THE MANURING OF MARKET GARDEN CROPS

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Calculation of Weights of Fertilisers for Small Plots.

In the following pages it will be found that all manurial applications are, for the sake of uniformity of comparison, calculated in quantities per acre. For readers who may wish to manure smaller areas than this, it may be convenient to give at once a short table enabling them to see at a glance what are the corresponding quantities for smaller areas of ground. We have therefore calculated the various dressings from 1 cwt. up to 8 cwt. per acre into their equivalent quantities for—

1 rood ($\frac{1}{4}$ of an acre).

1 square rod or perch ($\frac{1}{40}$ of a rood or $\frac{1}{160}$ of an acre).

1 square yard ($\frac{1}{4840}$ of an acre).

The calculation of dressings per yard is only approximate, but it will be found convenient for the use of readers who wish to make experimental trials on a small scale, or to manure even a few yards of domestic kitchen garden.

The various equivalent dressings are as follows :—

Quantity per acre.	Equivalent quantity per		
	Rood.	Square rod or perch.	Square yard.
cwt.	lbs.	lbs.	oz.
1	28	$\frac{3}{4}$	$\frac{3}{4}$
2	56	$1\frac{1}{2}$	$1\frac{1}{2}$
4	112	$2\frac{3}{4}$	$2\frac{3}{4}$
6	168	$4\frac{1}{2}$	$2\frac{1}{4}$
8	224	$5\frac{1}{2}$	3

The simple fertilisers used in our experiments, it may be added, can be obtained in quite small quantities from any reputable dealer in manures or horticultural requisites.

B. D.

F. W. E. S.

The Manuring of Market-Garden Crops.

By Bernard Dyer, D.Sc., F.I.C., and F. W. E. Shrivell, F.L.S.

INTRODUCTORY.

In the Journal of the Royal Horticultural Society for 1903, there appeared a full account of eight years' field trials on the growth of market garden crops, carried out by the authors on the farm of one of them at Golden Green, Hadlow, Tonbridge. This, by permission of the Society, was subsequently reprinted and issued as a separate publication. An account also appeared in 1903 in the Journal of the Board of Agriculture, and practical recommendations, based upon the principal results arrived at, have been embodied in an official leaflet on "Fertilisers for Market Garden Crops," of which copies can be obtained on application to the Secretary of the Board of Agriculture and Fisheries, 4, Whitehall Place, London.

The experimental work—begun in 1894—has been systematically continued until the experiments have now reached their twentieth year, and the following pages record the experience of the authors up to the beginning of the present season, 1913.

The work has mainly resolved itself into an inquiry as to how far the large quantities of purchased stable manure used by market gardeners are necessary, or how far, where necessary, they are being used to the greatest economical advantage.

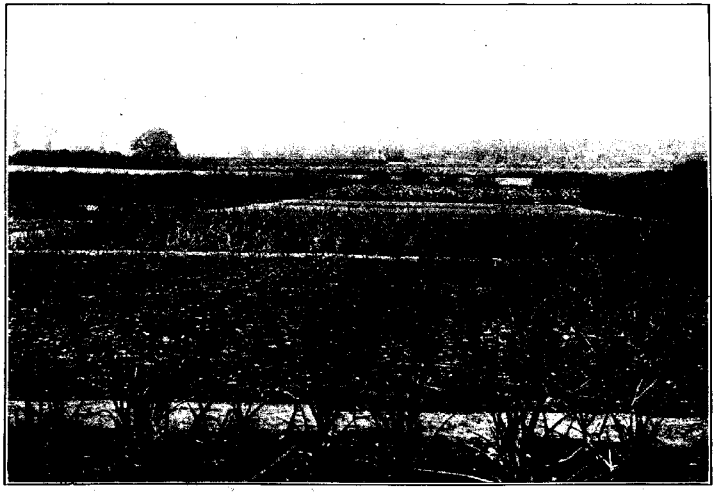
This question was a serious one even twenty years ago, but at the present day it has become more acute owing to the development of motor traffic and electric tramways, and the consequent enormous decrease in horse traction in our large cities. Town stable manure, which was once plentiful, is becoming comparatively scarce, and the competition for that which is still produced has resulted in a gradual rise in price, which is likely to continue as the diminishing output becomes more and more an object of competition among purchasers. Indeed, it appears likely that at no distant time town stable manure will be, for many of its long accustomed users, an unattainable luxury.

It is common knowledge that market garden crops are more heavily manured than any other crops, except hops, and that nowhere has stable manure been more prized than in the market garden. This is scarcely remarkable, seeing that for ages farmyard or stable manure was practically the only available manure, and that the home patch of vegetables which preceded the modern market garden, being in a position in which it could be easily and lavishly manured from the stable, the cowhouse, and the domestic rubbish heap, afforded an always near and striking object lesson as to the value of the then only manure to be had, with the result that the ideas of vegetable growing and of heavy applications of "natural" manure became correlatively fixed, even when vegetable gardening had grown into an important branch of broad acre farming.

A farm devoted essentially to market gardening, seeing that it does not grow straw crops and sells its green crops, cannot help to sustain itself in the matter of manure like a good arable farm, and its fertility must therefore be kept up mainly from outside. Since a market garden usually exists to supply large towns or cities, it is necessarily situated within fairly easy reach of them, and therefore within fairly easy reach also of the stable manure produced in them. If the journey to town is a road journey, it has long been the custom for the carts that take the produce into market to bring back stable manure, and in this case the cost of carriage of the manure has not been directly felt, although it is really paid for in wear and tear of the horses and carts. When the journey to town is a railroad one, the company's trucks take the place of the farm carts, and in this case the cost of carriage is directly felt.

At the time of the inception of these experiments the use of supplementary fertilisers in the market garden had not been wholly neglected, but the position they occupied in this industry relatively to stable manure was inconspicuous, compared with that occupied in ordinary farming. This condition of things has since been steadily altering. Moreover, the supplementary fertilisers most in vogue in the market garden used to be those of the more bulky kind—that is to say, of the kind more nearly allied to farmyard or stable manure—namely, raw fish, furriers' waste, woollen rags, shoddy, and the like; in fact, for the most part, the same kind of bulky manures which the hop farmer has long delighted in. Most of these manures are chiefly nitrogenous, and the market gardener, like the hop farmer, has probably not always been sufficiently alive to the consequences of neglecting to supply the phosphates necessary to balance the nitrogen in them, and to enable

GENERAL VIEW OF EXPERIMENTAL FIELD.



Showing in the left middle of picture the failure of a half-plot of Onions grown without any Stable Manure, which received only Phosphates and Nitrate without Potash, while the other half, receiving also Potash, shows a good crop.

them to do their full work. No doubt the better read and more thoughtful of our market gardeners have learned sufficient from ordinary farm practice to extend their system of manuring to the use of more concentrated fertilisers, such as guano, bone dust, dissolved bones, superphosphate, fish guano, nitrate of soda, and sulphate of ammonia; but it is probably not too much to say, even now, that their proportion is not large, relatively to the many who still neglect the aid offered by concentrated and easily portable fertilisers, and who question the virtue of any manure that does not, either by its bulk or by its smell, present some resemblance to farmyard or stable manure. With this preference there is no doubt associated the instinctive result of the experience which has taught that, on many soils, the application of bulky carbonaceous matter—for the formation of what the chemist calls "humus"—is a desideratum, and cannot without disadvantage be neglected. And this instinct is a sound one. But the formation of "humus," and the consequent improvement of the mechanical texture of the soil, although an important feature in manuring, is only one of the two principal objects of manuring, the other being to supply readily available plant food.

The stable manure, or "dung," supplied by large towns, is a different thing from farmyard manure. It consists largely of soiled straw or peat not half saturated with liquid excreta, and of solid horse manure from the streets, which is little more than undigested fodder—the valuable liquid excreta voided in the street being, of course, lost. The manure resulting from the street and stable scavenging of the town is consequently poorer than the cake-fed manure of the farmyard, and there is reason to suppose that the weight of town dung is sometimes augmented, to the advantage of the vendor and the disadvantage of the purchaser, by the liberal use of the hose or the pump. A further cause of diminution in the value of a reputed ton of town stable manure is the frequency of the mistakes in weight which may sometimes be discovered by those who take the trouble to use a weigh-bridge to check their deliveries of this commodity.

In order to make up for the relative poverty of town manure, it is customary to use much larger quantities of it per acre than would be used in the case of ordinary farming with farmyard manure, and this can only be done at a large expense. The cost of town stable manure on rail in London three years ago had risen to about 3*s.* to 3*s.* 6*d.* per ton during the time of chief demand. It was cheaper in summer, when farmers having no immediate use for it were reluctant to buy, in view of

the deterioration in value consequent upon long heaping and storing. At present only the cheaper qualities, including miscellaneous refuse, are obtainable for 3*s.* 6*d.* a ton on rail. Good stable manure on rail in London is charged for at the rate of from 4*s.* to 4*s.* 6*d.* per ton, and the drop in price in summer is no longer continued, since farmers prefer to buy it and face the loss consequent upon storage, rather than run the risk of being unable to get it when they want it. The cost of carriage may be taken as varying from 2*s.* per ton for twenty-five miles or under, up to 3*s.* 6*d.* per ton for fifty miles. Thus the manure delivered in trucks at a local station will now cost from 6*s.* to 8*s.* per ton. If we assume an average distance of two miles from the station to the farm, cartage at 9*d.* per mile would bring up the cost, on a farm from twenty to fifty miles distant from London, to from 7*s.* 6*d.* to 9*s.* 6*d.* per ton. At Hadlow during the last twenty years its actual cost at the farm has been about 8*s.* per ton. At the present time it is costing nearer 10*s.* a ton, and it is probably only on very favourably situated farms, such as those for which water carriage is available, or which are within easy carting distance from town, that good purchased stable manure costs as little as 7*s.* per ton on the farm.

Market gardeners seldom use a dressing of less than 25 tons of stable manure per acre, costing, in round figures, something approaching £10 per acre—a quantity insufficient to grow maximum crops; while they often use as much as 50 tons, costing about £20 per acre in one dressing. Occasional applications even exceeding this are not unknown for onions.

Prior to the inception of the trials about to be described, it had long been the conviction of one of the authors that such heavy dressings must be economically imprudent for at least some crops, and that market gardeners would do better for themselves by using smaller quantities of purchased stable manure, and spending a portion of the money thus saved on concentrated fertilisers, thereby getting increased crops and at the same time keeping the cash balance in their pockets. This conviction was held without any blindness to the particular virtues of stable manure, which, as has been already indicated, constantly adds to the store of "humus" or organic matter in the soil, thus giving it a mechanical condition which corrects the inherent physical shortcomings peculiar to sandy soils in the one extreme and to heavy clays in the other. Probably the most intrinsically valuable property that "dung" possesses is its power of regulating the absorption and evaporation of water, and for this property alone it is so useful on almost any soil that the market gardener, even more than the farmer,

cannot afford to neglect it. But, while it retains its reputation for mechanical improvement, it has long ceased to be the only source of plant food that could be added to those derived from the unaided soil and from the atmosphere, and, regarded merely as a source of readily available nitrogen, phosphates and potash, it appeared very questionable whether it was not too expensive for use in sufficient quantity to maintain the soil at a maximum of productive power for vegetable crops. But, until the commencement of the experiments now to be recorded, very little, if any, investigational work had been carried out to test the validity of these views. It happened that, now twenty years ago, one of the authors was consulted by the late Mr. Hillman (then Secretary of the Permanent Nitrate Committee) as to the drawing up of some practical instructions for the use of nitrate of soda for vegetable growing a subject on which inquiries were occasionally being made by gardeners who happened to have heard something of this particular fertiliser. It was found that very little definite or reliable information appeared then to exist as to the best mode of using either this or any other artificial fertiliser for vegetable or market garden crops. While endless experiments had been made with all sorts of fertilisers on the ordinary farm, scarcely any had been recorded either in the market garden or in the kitchen garden, and all the detailed advice that could be given was necessarily cautious, meagre, and based largely on analogy. To meet the difficulty the Committee, having at its disposal a trust fund for encouraging experimental work on fertilisers, liberally offered to defray the expense of a series of practical field trials on the subject. This offer of help in the investigation of a question on which investigation was much needed, was gladly welcomed, and resulted in the co-operation of the authors and the establishment, under their joint direction, of the now well-known experiment station at Hadlow, where they have been able to study the behaviour of a large variety of crops under a considerable variety of seasons. The scope and diversity of the work may to some extent be indicated at the outset by the statement that the produce of considerably more than 300 plots or sub-plots of vegetables is weighed separately every year. Many of the questions which have been experimentally put to the test have now been sufficiently answered, but others are still under investigation. The authors, on entering on the twentieth year of their work, wished again to record *publicly their thanks* to the Committee (now reconstituted as the Chilean Nitrate Committee) for having thus far continued to defray its expense, and also for enabling it to be extended collaterally to investigations relating to the manuring

of hops and of various agricultural crops, which, however, lie outside of consideration in the present treatise.

It will be seen hereafter that in the main the experience accumulated indicates that, on soils in fairly good mechanical condition, if one could but predict a rainfall normal in quantity and distribution, it would probably be economical to dispense with stable manure altogether for many vegetable crops, although not by any means for all. The market gardener, however, must insure himself against the uncertainties of season, and cannot afford to forego altogether the valuable mechanical assistance derivable from stable manure, even at the risk of some extravagance. Our experience, nevertheless, indicates conclusively that the average bill for stable manure can be largely reduced, without detriment to either the size or the quality of the crops, provided that the grower supplements the diminished quantity of stable manure with a suitable mixture of chemical or concentrated fertilisers. This course, as will be shown, is accompanied by a large pecuniary saving, and will, indeed, before very long become compulsory.

THE SOIL.

THE soil of the farm on which the experiment station was established varies very much in richness, and it was considered that for experimental purposes it would be desirable to select a poor field, and one as free as possible from the influence of recent previous manuring. We therefore chose a large arable field which for a long time had not been under hop or fruit culture, but which had been treated as ordinary rotation arable land. Those who are familiar with hop farming will know that, as a rule, no very great affection is lavished by hop farmers on those portions of their farms which are not regarded, either presently or prospectively, as hop land. The field in question has been only sufficiently manured to enable it to produce fair crops in ordinary rotation, while its natural or inherent fertility was probably not unfairly indicated by the name which the field bears on the plan of the estate, namely, "Snatchlands."

The soil of the main experimental field is a poor clay-loam, or brick earth of lightish colour, resting upon a deep bed of heavy clay. Its natural poverty has already been alluded to, and it has been an interesting object-lesson to watch its gradual conversion, under the influence of spade cultivation and assiduous manuring, into a fertile market garden. To chemists the natural poverty of the soil will be

indicated by the following analysis of a fair sample of the surface soil made before the beginning of the experiments :—

Silica and silicious matters undissolved by strong hydrochloric acid from the ignited soil	89·120
Matters dissolved by strong hydrochloric acid from the ignited soil :—	
Oxide of Iron	3·396
Alumina	2·680
Lime	0·313
Magnesia	0·200
Potash	0·219
Soda	0·187
Phosphoric Acid	0·084
Sulphuric Acid	0·034
Water of combination, organic matter, etc.	3·767
	100·000
Nitrogen	0·101
The Potash includes :—	
Potash soluble in dilute (1 per cent.) citric acid solution (probably readily "available" potash)	0·004
The Phosphoric Acid includes :—	
Phosphoric Acid soluble in dilute (1 per cent.) citric acid solution (probably readily "available" phosphoric acid)	0·005

It will be seen that the soil is naturally poor in lime; and the quantity of phosphoric acid soluble in dilute citric acid solution clearly indicates the natural need of the field for phosphatic manure, and the proportion of soluble potash is sufficiently low to indicate also the need for potassic manure, and to account for the marked effect produced by potash salts on some of our crops, especially on those plots on which no dung has been used. It will also be seen that the stock of organic nitrogen derived from the residues of previous crops is also low, as is also the proportion of total organic matter; the soil is therefore also well adapted for experiments involving an inquiry into the comparative value of nitrogenous manure for various crops.

A portion of this field, which in the autumn of 1893 had been sown with wheat, was ploughed up during the winter and well dug, to prepare it as far as possible for the first season's trials. After the first season—that is to say, at the close of 1894—being poor in lime, it was limed at the rate of 2½ tons of lime per acre, and this treatment was repeated a year later.

GENERAL PLAN OF THE TRIALS.

THE general plan of the experiments has been designed to obtain answers to the following questions :—

Is it more economical, in the case of any particular market garden crop, to use light or heavy dressings of purchased stable manure?

How far can purchased stable manure, with due regard to economy, be partially replaced by simple chemical fertilisers?

Assuming nitrate of soda to be the nitrogenous fertiliser employed, what quantity is it most economical to use, in conjunction with phosphates and with or without potash, in partial replacement of stable manure?

For what, if any, vegetable or fruit crops is it possible economically to dispense with stable manure altogether and to get as good a result by using chemical fertilisers only?

We have experimented with a large variety of vegetable and fruit crops. Those crops which only occupy the ground for one season are usually grown in rotation, so that, as a rule, two crops of the same kind do not immediately follow each other on the same plot. The general plan followed was to devote annually six plots to each kind of vegetable grown, each plot being usually one-fiftieth of an acre in area. During the first five years the following general scheme of plots was followed:—

PLOT A. LIGHT DUNG and PHOSPHATES with 1 cwt. NITRATE per acre. No Potash. | Potash.	PLOT B. LIGHT DUNG and PHOSPHATES with 2 cwt. NITRATE per acre. No Potash. | Potash.
PLOT C. NO DUNG; PHOSPHATES with 4 cwt. NITRATE per acre. No Potash. | Potash.	PLOT D. LIGHT DUNG and PHOSPHATES with 4 cwt. NITRATE per acre. No Potash. | Potash.
PLOT E. LIGHT DUNG (25 loads, or 12½ tons, per acre).	PLOT F. HEAVY DUNG (50 loads, or 25 tons, per acre).

It will be seen that one plot (F) receives a heavy dressing of stable manure, and four plots (A, B, D, and E) each receive half the quantity of stable manure applied to Plot F. In the case of plots A, B, and D, this light dressing of stable manure is supplemented by a dressing of phosphatic manure, with varying quantities of nitrogen supplied in the

form of nitrate of soda, each of these plots being sub-divided into two, one half receiving potash salts and the other half no potash salts—the dressing otherwise on each plot being uniform. One plot (C) on each section is left continuously without stable manure, but is liberally dressed with chemical fertilisers, one half receiving potash salts and the other half no potash salts.

For a large number of crops this scheme was modified later to the following form, the only difference being that the quantities of nitrogen applied to each plot are relatively larger. For crops, however, on which earlier experiment indicated that large dressings of nitrogen were not required, the earlier plan has been followed.

PLOT A. LIGHT DUNG and PHOSPHATES with 2 cwt. NITRATE per acre. No Potash. | Potash.	PLOT B. LIGHT DUNG and PHOSPHATES with 4 cwt. NITRATE per acre. No Potash. | Potash.
PLOT C. NO DUNG; PHOSPHATES with 8 cwt. NITRATE per acre. No Potash. | Potash.	PLOT D. LIGHT DUNG and PHOSPHATES with 6 cwt. NITRATE per acre. No Potash. | Potash.
PLOT E. LIGHT DUNG (25 loads, or 12½ tons, per acre).	PLOT F. HEAVY DUNG (50 loads, or 25 tons, per acre).

In the case of some crops (carrots, for example) the application of stable manure is intermittent; that is to say, no direct applications of stable manure are made, the crop being grown on land on which stable manure has been used for the previous crop—this, we believe, being in accordance with the best market-garden practice.

The dung used is in all cases town stable manure or "dung" purchased from London.

As to concentrated or artificial fertilisers, in order to avoid any accumulation of acidity in the soil—the proportion of lime being small—we vary the phosphatic manure, using sometimes superphosphate (which is, of course, acid), and sometimes basic slag, which is alkaline. Since phosphates are required by all crops, and cost relatively little, no particular

interest attaches in market gardening to special economy in the direction of phosphatic manure, provided only that a sufficiency be given; and, as no harm is likely to arise from giving an excess, we have treated the ground liberally in this respect. Of superphosphate we have used from 4 cwt. to 6 cwt. per acre, and of basic slag from 7 cwt. to 10 cwt. per acre. The actual dressings of phosphates per acre in the various years were as follows:—

1894.	4 cwt. Superphosphate and 4 cwt. Basic Slag, mixed.	1903.	6 cwt. Superphosphate.
1895.	4 cwt. Superphosphate.	1904.	10 cwt. Basic Slag.
1896.	6 cwt. Superphosphate.	1905.	6 cwt. Superphosphate.
1897.	7 cwt. Basic Slag.	1906.	10 cwt. Basic Slag.
1898.	4 cwt. Superphosphate.	1907.	6 cwt. Superphosphate.
1899.	6 cwt. Superphosphate.	1908.	8 cwt. Basic Slag.
1900.	10 cwt. Basic Slag.	1909.	4 cwt. Superphosphate.
1901.	6 cwt. Superphosphate.	1910.	8 cwt. Basic Slag.
1902.	6 cwt. Superphosphate.	1911.	6 cwt. Superphosphate.
		1912.	8 cwt. Basic Slag (where used).

As a source of potash we have sometimes used sulphate of potash and sometimes kainit, alternating the two, the quantity used per annum being 1 cwt. of sulphate of potash or 4 cwt. of kainit per acre.

It has been necessary, owing to the large number of crops under investigation, to keep our choice of concentrated fertilisers as simple as possible. In the case of phosphates we have restricted our choice to superphosphate and basic slag, used, not in comparison with one another, but alternately. This has not been due to any kind of conviction that these are, under all circumstances, to be preferred to other forms of phosphatic fertilisers. On the contrary, we believe that, in this kind of farming, guano, bone meal, and dissolved bones find a specially appropriate place.

Speaking generally of the choice of phosphates, it may probably be laid down as a good rule that, on soils containing sufficient carbonate of lime to effervesce when mixed with dilute mineral acid, the best form of phosphates to use is either superphosphate or some similar form of acid manure, such as dissolved guano or dissolved bones. On soils, however, which are deficient in carbonate of lime, it will be better to use either basic slag, raw Peruvian guano, or bone meal; or a mixture of bone meal and superphosphate; or the material introduced into the market some years ago, on the suggestion of Mr. John Hughes, under the name of "basic superphosphate," which consists of superphosphate neutralised with lime. At any rate, one or other of these manures should be applied alternately with superphosphate.

ANOTHER GENERAL VIEW OF EXPERIMENTAL FIELD.



Similarly, it has been impracticable, as well as beyond the direct scope of our inquiry, to compare the relative efficacy of nitrate of soda with that of other well-known concentrated and rapidly acting nitrogenous fertilisers, such as sulphate of ammonia or Peruvian guano, or with that of less rapid but, when properly used, efficacious organic manures like fish guano, rape meal, etc. It has already been explained that our scheme of experiments already involves over three hundred separate plots or sub-plots, the produce of each of which has to be gathered and weighed separately, so that the impracticability of undertaking comparative trials between nearly allied fertilisers will be apparent. Probably many of the results that we have obtained by the use of nitrate of soda and superphosphate or basic slag might have been equally well obtained, on some soils, by the use of sulphate of ammonia, rape dust, or fish guano with bone meal or dissolved bones; or by the use of Peruvian guano, raw or dissolved; each of such manures, of course, being applied in the fashion best suited to its special rate of activity. The results that we have obtained, however, with the simple materials, nitrate of soda, phosphates, and potash salts, will, we hope, show how far we may go in the liberal nitrogenous feeding of vegetable and fruit crops; and we hope that those who are disposed to make comparative trials between the concentrated fertilisers used by ourselves and other more or less kindred fertilisers which have been enumerated, will find that our work has served to indicate to them the most probable lines of successful experiment.

Our scheme of experiments, it will have been gathered, enables us to contrast the effects of light and heavy dunging continuously practised year after year, and also to compare or contrast light and heavy dunging with light dunging supplemented by the use, in different quantities, of concentrated chemical fertilisers; and also with the effects of the latter when unaccompanied by stable manure.

RESIDUAL VALUE OF MANURES.

Many of our experiments on vegetables having been repeated sufficiently often to enable us to arrive at definite conclusions, we determined at the close of the season 1911 to devote a number of the sections of the main experimental field to ascertaining the residual effects of the fertilisers applied during the previous eighteen years. Accordingly, on many of the sections we have ceased to apply either stable manure or artificial fertilisers, but are continuing to grow on them various vegetables, weighing separately, as heretofore, the produce from each plot. An account of the results for 1912 is given on pp. 145–149.

RAINFALL.

Our annual rainfall record, as indicated by rain-gauge observations on the farm, has, on the whole, been low as compared with the records taken in the neighbouring town of Tonbridge, which is only about four miles distant. Hadlow, however, lies in a basin surrounded by hills, and many rain-storms break on the edge of the basin without reaching us. On the whole, our climate may be said to be a dry one, even for the neighbourhood. We give a table showing the rainfall for each month from 1895 to 1912 inclusive.

During a number of years, especially in the earlier part of our work, we suffered a good deal from lack of rain at some period or another of the summer. In a market garden, bad weather, whether it take the form of excessive cold, excessive heat, excessive moisture, or excessive drought, must in the nature of things come at a time which is critical for some one or other of the many crops cultivated. Even in especially dry seasons, considerable variations occur in the distribution of the total rainfall over the various months in different years, and though we may have consecutively two or three seasons which may be all classed as dry, yet the drought of one year may occur at such a time as to injuriously affect one crop and in another year at such a time as to injuriously affect another crop; while, conversely, even a scanty total rainfall may so vary in its distribution as to favour one crop in one year and another crop in another. The same remarks apply to wet seasons. It is, therefore, only by collating and averaging the experience obtained over a number of years that general results, not much affected by individual seasons, can be arrived at; and the larger the number of seasons included in the record, the more trustworthy is the information gained. In the earlier years, owing to the dry weather experienced at certain times of the year, we were often a little diffident in responding to requests for advice relating to the manuring of some crops on which we had experimented. Now, after nearly twenty years, although we feel that much remains for us to learn, even on the lines on which we have been working, we are in a better position to make suggestions to those who care for them, and this not merely in virtue of our own experience, but on account of the wide interest which has been shown in our work by practical growers of fruit and vegetables on both a large and a small scale all over the country, which has afforded one or the other of us very many opportunities of conversing and comparing notes with others as to the practical results

	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.	1912.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
January .	2·11	0·72	1·48	0·57	2·94	3·01	0·96	0·97	2·06	4·16	1·13	3·82	1·24	1·95	1·27	2·60	1·12	2·49
February .	0·50	0·30	2·51	1·24	2·41	5·25	1·61	1·22	1·37	3·19	1·10	1·81	1·22	1·19	0·68	3·98	1·38	1·72
March .	1·52	2·44	3·99	1·46	0·93	1·00	2·08	1·60	2·44	1·57	3·44	1·64	1·14	2·57	3·57	1·58	2·34	3·95
April . .	1·91	0·60	1·98	0·91	2·70	0·85	1·70	0·51	2·02	0·89	2·69	1·13	2·54	2·33	1·57	2·21	2·03	0·04
May . .	0·06	0·33	0·92	3·06	1·34	1·14	0·61	2·42	1·81	1·98	1·01	1·43	1·90	1·16	1·30	2·72	2·13	0·94
June . .	0·23	3·23	1·86	1·46	0·97	3·32	1·67	2·15	5·34	0·90	4·02	2·00	1·84	1·50	2·78	2·48	2·07	2·75
July . .	2·85	0·83	0·30	0·46	1·35	1·34	1·91	2·12	6·41	1·18	1·31	0·38	0·96	2·21	2·90	2·65	0·35	1·22
August .	1·66	1·52	2·20	1·22	1·63	2·06	1·69	2·79	2·92	1·39	2·31	0·88	2·11	4·70	2·52	2·11	0·60	5·81
September .	0·38	5·75	2·88	0·35	2·62	0·83	1·03	1·82	2·10	1·29	1·76	1·33	0·49	1·18	2·87	0·51	1·48	2·77
October .	2·89	3·62	0·36	2·72	1·81	2·08	2·33	2·27	5·42	1·74	1·51	3·87	4·30	1·72	4·26	2·26	4·77	3·33
November .	5·63	1·47	1·18	2·59	4·39	2·74	0·72	1·97	2·26	1·52	3·87	5·59	2·15	0·91	0·95	3·36	5·39	2·38
December .	3·81	3·38	3·39	2·21	1·55	2·98	3·95	1·60	2·03	3·29	0·62	1·71	2·61	2·43	3·65	3·40	5·47	3·08
Total .	23·55	24·19	23·05	18·25	24·64	26·60	20·26	21·44	36·18	23·10	24·77	25·59	22·50	23·85	28·32	29·86	29·03	30·48

which they have individually obtained by following our methods of manuring.

With regard to some of our crops, more especially the fruit crops, we are still not in a position to offer the clear and definite advice that we are able to tender with regard to most of the field vegetables which we have grown; for fruit farming on the experimental scale is not different from fruit farming on the large scale in respect of the many vicissitudes to which fruit crops are liable, owing to weather fluctuations (especially the incidence of early frosts) and the effects of the pests of one sort and another to which such crops are liable—all of these being factors which have not necessarily any relation to the fertilisation of the soil on which the crops are grown.

CAULIFLOWERS (AUTUMN-CUT).

We have recorded the results of eighteen crops of Autumn Cauliflowers, manured in accordance with the general scheme of experiments.

The mode of gathering the crop has been to go over the ground daily during the flowering season and to gather and weigh separately each head just as it has reached a state of maturity, when the flower shows signs of beginning to break. By gathering all the heads in the same condition of comparative maturity, the aggregate weights obtained from the different plots are rendered comparable.

For the first five crops no nitrate dressings larger than 4 cwt. per acre were given, but for the last thirteen seasons plots have been included with heavier dressings of nitrate. In the table opposite are set forth the average results obtained with the lighter dressings during the whole eighteen seasons, and also the average results obtained during the last thirteen years, when the heavier dressings of nitrate were included. In this table are given only the results obtained on the plots receiving stable manure, with or without chemical fertilisers; the results obtained by the use of chemical fertilisers only are given in a separate table.

The first point that is apparent is that the heavy dressing of dung, although it has largely increased the crop as compared with the light dressing, has nevertheless failed to give anything like such good results as have been obtained by the use of the lighter dressing of dung supplemented by chemical fertilisers, and this notwithstanding that the heavy application of dung is the most expensive dressing of all.

Whether we take the longer or the shorter series of years, we see

that the extra twenty-five loads of dung have increased the weight of the crop by only about 3½ tons per acre, whereas, by the judicious substitution of chemical fertilisers for the extra dung, we have been able to increase the average weight of the crop by 6 to 8 tons per acre.

During the earlier period no advantage was derived from increasing the nitrogenous dressing beyond 4 cwt. of nitrate of soda per acre, but on the average of the last thirteen seasons there has been some advantage from the heavier nitrate dressing.

Potash salts on these dunged plots have not on the average produced much increase, but during the later years there have been several seasons in which they have produced a decided effect, except where the heaviest dressing of nitrate has been used.

CAULIFLOWERS.

PLOTS RECEIVING STABLE MANURE.

Annual Manuring per acre.	Average annual cost of manure per acre.	Eighteen seasons (1894-1911). Average gross annual weight of heads per acre.	Eighteen seasons (1894-1911). Approximate average weight per head.	Last Thirteen seasons (1899-1911.) Average gross annual weight of heads per acre.	Last Thirteen seasons (1899-1911.) Approximate average weight per head.
	£ s. d.	tons cwt.	lbs.	tons cwt.	lbs.
50 loads (25 tons) London Dung	10 0 0	19 7	4·24	21 0	4·37
25 loads (12½ tons) London Dung	5 0 0	15 19	3·48	17 4	3·55
25 loads Dung, Phosphates (no Potash Salts), and 2 cwt. Nitrate of Soda	7 0 0	20 1	4·42	21 13	4·52
Do., do., with Potash Salts	7 10 0	20 16	4·57	22 16	4·73
25 loads Dung, Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	8 2 0	22 2	4·84	24 5	5·04
Do., do., with Potash Salts	8 12 0	22 2	4·84	24 8	5·05
25 loads Dung, Phosphates (no Potash Salts), and 6 cwt. Nitrate of Soda	9 4 0	—	—	25 11	5·30
Do., do., with Potash Salts	9 14 0	—	—	25 9	5·28

We now come to the results obtained on the plots to which no dressing of dung has been applied. These are given in the table on the next page, and with them, for comparison, are again given the results of the most important of the dunged plots.

It will be seen that chemical fertilisers alone (that is to say, on soil to which no dung of any kind has been applied during the whole of the experimental period) have yielded heavier crops than have been obtainable by the use of a full dressing of dung alone. During the last thirteen years we have been able to grow on the average nearly 23½ tons of cauliflower heads per acre, averaging nearly 5 lbs. per head, merely by using liberal dressings of phosphates, potash salts, and nitrate of soda, at a cost of £5 16*s.* per acre; whereas heavy dung alone, at a cost of £10 per acre, has only produced 21 tons of cauliflower heads, averaging less than 4½ lbs. per head. The results are not so good as those obtained by the use of a combination of light dung and chemical fertilisers, but they were obtained at a smaller expense.

CAULIFLOWERS.

COMPARISON OF PLOTS WITH AND WITHOUT STABLE MANURE.

Annual manuring per acre.	Average annual cost of manure per acre.	First five seasons (1894-1898).		Last thirteen seasons (1899-1911).	
		Average gross annual weight of heads per acre.	Approximate average weight per head.	Average gross annual weight of heads per acre.	Approximate average weight per head.
	£ s. d.	tons cwt.	lbs.	tons cwt.	lbs.
50 loads (25 tons) London Dung	10 0 0	15 0	3·94	21 0	4·37
25 loads (12½ tons) London Dung	5 0 0	12 12	3·31	17 4	3·55
25 loads Dung, Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	8 2 0	16 13	4·31	24 5	5·04
Do., do., with Potash Salts	8 12 0	16 5	4·31	24 8	5·05
25 loads Dung, Phosphates (no Potash Salts), and 6 cwt. Nitrate of Soda	9 4 0	—	—	25 11	5·30
Do., do., with Potash Salts	9 14 0	—	—	25 9	5·28
No Dung, Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	3 2 0	14 11	3·75	—	—
Do., do., with Potash Salts	3 12 0	15 0	3·94	—	—
No Dung, Phosphates (no Potash Salts), and 8 cwt. Nitrate of Soda	5 6 0	—	—	20 5	4·21
Do., do., with Potash Salts	5 16 0	—	—	23 9	4·88

FROM A SPECIMEN CROP OF BROCCOLI.



Crop, 13 tons 10 cwt. per acre.
Manure per acre—
12½ tons London Dung

(cost £5 per acre).

Crop, 18 tons 19 cwt. per acre.
Manure per acre—
12½ tons London Dung,
4 cwt. Superphosphate,
4 cwt. Nitrate of Soda

(cost £7 10s. per acre).

As might be expected, the effect of potash has been much more marked in the case of the plots receiving no dung than in the case of those on which dung in small quantities is used from year to year.

The advantage derived from the use of chemical fertilisers, whether with or without stable manure, is not confined to a mere increase in the size of the heads. The cauliflowers grown with the aid of chemical fertilisers have constantly been observed to be of better quality than those grown with dung alone, the midribs of the sheathing leaves being so tender and free from tough vascular tissue as to be soft and readily edible, while those of the heads grown on companion plots with dung alone have been comparatively tough and fibrous at the base, as is usually the case in the full-grown cauliflower of the market.

RECOMMENDATION as to Manuring of CAULIFLOWERS.

Summarising our experience thus far, we should be inclined generally to recommend for cauliflowers a light dressing of stable manure (12½ tons or 25 small loads per acre) with from 4 to 6 cwt. of superphosphate and 4 cwt. of nitrate of soda per acre—half the nitrate being applied at the time of planting, and the remainder a month or two later. If the dung supply should be short, cauliflowers may very well be grown without dung, even on land that has not been recently dunged. In that case 6 cwt. of superphosphate and 4 cwt. of kainit (or 1 cwt. of sulphate of potash) per acre should be well incorporated with the soil before planting. Nitrate of soda at the rate of 4 cwt. per acre should then be sown between the rows directly the plants are well established, a further dressing of from 2 to 4 cwt. of nitrate per acre being given a month later. When no dung is used, a dressing of potash salts should not be omitted. On land that is deficient in lime, superphosphate may be replaced by basic slag, "basic superphosphate," phosphatic Peruvian guano, or a mixture of fine bone meal and superphosphate, used in liberal quantities.

BROCCOLI (WINTER CAULIFLOWERS).

We have grown seventeen crops of Broccoli, or Winter Cauliflowers, on the same plan of manuring followed in the case of cauliflowers. The results are similarly set out in the tables on the next page.

BROCCOLI.

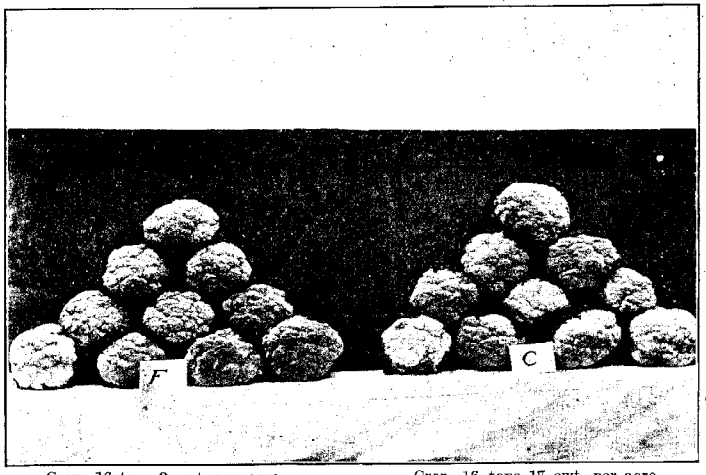
PLOTS RECEIVING STABLE MANURE.

Annual manuring per acre.	Average annual cost of manure per acre.	Seventeen seasons (1894-95 to 1910-11). Average gross annual weight of heads per acre.	Seventeen seasons (1894-95 to 1910-11). Approximate average weight per head.	Last twelve seasons (1899-1900 to 1910-11). Average gross annual weight of heads per acre.	Last twelve seasons (1899-1900 to 1910-11). Approximate average weight per head.
	£ s. d.	tons cwt.	lbs.	tons cwt.	lbs.
50 loads (25 tons) London Dung	10 0 0	14 2	3·00	15 5	3·21
25 loads (12½ tons) London Dung	5 0 0	12 4	2·57	13 5	2·80
25 loads Dung, Phosphates (no Potash Salts), and 2 cwt. Nitrate of Soda	7 0 0	14 6	3·02	15 3	3·15
Do., do., with Potash Salts	7 10 0	13 18	3·05	14 11	3·19
25 loads Dung, Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	8 2 0	15 13	3·29	16 11	3 44
Do., do., with Potash Salts	8 12 0	15 17	3·34	17 3	3·56
25 loads Dung, Phosphates (no Potash Salts), and 6 cwt. Nitrate of Soda	9 4 0	—	—	17 3	3·56
Do., do., with Potash Salts	9 14 0	—	—	18 9	3·82

COMPARISON OF PLOTS WITH AND WITHOUT STABLE MANURE.

Annual manuring per acre.	Average annual cost of manure per acre.	First five seasons (1894-95 to 1898-99). Average gross annual weight of heads per acre.	First five seasons (1894-95 to 1898-99). Approximate average weight per head.	Last twelve seasons (1899-1900 to 1910-11). Average gross annual weight of heads per acre.	Last twelve seasons (1899-1900 to 1910-11). Approximate average weight per head.
	£ s. d.	tons cwt.	lbs.	tons cwt.	lbs.
50 loads (25 tons) London Dung	10 0 0	11 6	2·48	15 5	3·21
25 loads (12½ tons) London Dung	5 0 0	9 14	2·14	13 5	2·80
25 loads Dung, Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	8 2 0	13 8	2·94	16 11	3·44
Do., do., with Potash Salts	8 12 0	12 16	2·83	17 3	3·56
25 loads Dung, Phosphates (no Potash Salts), and 6 cwt. Nitrate of Soda	9 4 0		—	17 3	3·56
Do., do., with potash Salts	9 14 0	—	—	18 9	3·82
No Dung, Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	3 2 0	11 7	2·51	—	—
Do., do., with Potash Salts	3 12 0	11 13	2·59	—	—
No Dung, Phosphates (no Potash Salts), and 8 cwt. Nitrate of Soda	5 6 0	—		15 9	3·19
Do., do., with Potash Salts	5 16 0	—	—	17 4	3·41

FROM ANOTHER SPECIMEN CROP OF BROCCOLI.



Crop, 16 tons 3 cwt. per acre.
Manure per acre—
25 tons London Dung
(cost £10 per acre).

Crop, 16 tons 17 cwt. per acre.
Manure per acre—
No Dung,
4 cwt. Superphosphate,
4 cwt. Kainit,
4 cwt. Nitrate of Soda
(cost £3 per acre).

It will be seen that the increase in crop obtained by doubling the dressing of dung has, notwithstanding the large expense of this dressing, been considerably less than the increase obtained by supplementing the lighter dressing of dung with concentrated fertilisers; and furthermore, that concentrated fertilisers alone—that is to say, without the aid of any dung whatsoever—have been shown capable of producing a substantially larger crop than was obtained with a dressing of fifty loads of dung per acre without their aid. Broccoli differ from cauliflowers in that they live through the winter and ripen in the spring, and this is perhaps why the physical effects of stable manure appear to tell less than in the case of cauliflowers.

RECOMMENDATION as to Manuring of BROCCOLI.

If stable manure is used for this crop, not more than a light dressing should be given, and this should be supplemented by superphosphate or other phosphatic manure (as recommended for cauliflowers), and 4 cwt. of nitrate of soda per acre. On heavy soils the dressing of nitrate of soda can apparently be increased even to 6 cwt. per acre with advantage. The nitrate should be applied in the same way as for cauliflowers. An allowance of 6 cwt. may appear liberal as compared with the quantity given for cauliflowers when dung is used, having regard to the smaller weight of the broccoli heads; but it is to be remembered that the nitrate must be applied while there is sufficient bare ground between the plants to allow of its being sown. It cannot be applied at the close of winter, when the leaves hide the ground, and therefore such a liberal supply should be given as will make allowance for some loss owing to winter drainage before the time at which the plant flowers. Our experiments seem to indicate, however, that dung may very well be omitted altogether for broccoli, at all events on land which has been dunged for a previous crop. In this case the dressing of phosphates should be liberal—not less than 6 cwt. per acre of superphosphate, or its equivalent—and should be accompanied by a dressing of 4 cwt. of kainit or 1 cwt. of sulphate of potash per acre. From 6 cwt. to 8 cwt. of nitrate of soda per acre may be given, half being applied early and half as late in the season as the growth of the plant allows. The nitrate should not be allowed to fall on the leaves.

BROCCOLI (SPROUTING).

A SIMPLE experiment on three plots—utilising an odd corner of ground—

has been made for the last three years with sprouting broccoli, with the following results:—

SPROUTING BROCCOLI.

Annual manuring per acre.	Average annual cost of manure per acre.	Weight of Sprouts gathered (calculated per acre). Average of five seasons.
	£ s. d.	tons cwt.
50 loads (25 tons) London Dung .	10 0 0	12 2
25 loads (12½ tons) London Dung .	5 0 0	9 15
25 loads London Dung, Phosphates, Potash Salts and 4 cwt. Nitrate of Soda	8 12 0	12 4

Here again the use of a heavy dressing of dung appears to be extravagant, equal results on the average being more economically obtained by the use of the lighter dressing of dung accompanied by chemical fertilisers.

AUTUMN-CUT OR MAIN-CROP CABBAGES

(that is to say, the ordinary Cabbage planted out in summer and cut in the autumn).

NEXT to potatoes these form perhaps the largest crop of the market gardener. They are well known as what is called an exhausting crop, being "hungry feeders," and both their weight and their quality are readily influenced by manuring. What has been already said of the effect of chemical fertilisers, as compared with stable manure, on the tenderness of cauliflowers applies also to cabbages. The large, quickly developed cabbages rapidly grown with phosphates and a liberal application of nitrate of soda, either with or without stable manure, are less fibrous and more succulent and tender than the plants raised on stable manure alone, even when as much as fifty loads per acre are used.

We have grown eighteen crops of these cabbages, usually of the variety well known as the "Enfield Market" cabbage. The first five crops were grown on our original plan of experiment, but we have since adopted the modified plan including larger nitrogenous dressings. In the following tables we have omitted the results of the potash plots, except in the case of the crops grown without stable manure, for the reason that cabbages of this kind appear to possess greater natural facility in availing themselves of natural potash resources, even when these are slender, so that potash on the average has produced no increase in the results except on that part of the land which is continuously kept without

AUTUMN CABBAGES.



12½ tons London Dung per acre

(cost £5 per acre).

No Dung, 6 cwt. Superphosphate,
8 cwt. Nitrate of Soda,
1 cwt. Sulphate of Potash per acre

(cost £5 5s. per acre).

stable manure. Here, during later years more especially, the application of potash salts has told materially.

AUTUMN-CUT CABBAGES.

PLOTS RECEIVING STABLE MANURE.

Annual manuring per acre.	Average annual cost of manure per acre.	Average annual weight of cabbages per acre.	
		Eighteen seasons (1894-1911).	Last thirteen seasons (1899-1911).
	£ s. d.	tons cwt.	tons cwt.
50 loads (25 tons) London Dung .	10 0 0	24 0	24 8
25 loads (12½ tons) London Dung .	5 0 0	20 5	20 2
25 loads London Dung, Phosphates, and 2 cwt. Nitrate of Soda	7 0 0	25 15	26 1
25 loads London Dung, Phosphates, and 4 cwt. Nitrate of Soda	8 2 0	27 6	27 12
25 loads London Dung, Phosphates, and 6 cwt. Nitrate of Soda	9 4 0	—	30 8

COMPARISON OF PLOTS WITH AND WITHOUT STABLE MANURE.

Annual manuring per acre.	Average annual cost of manure per acre.	Average annual weight of cabbages per acre.	
		First five seasons (1894-1898).	Last thirteen seasons (1899-1911).
	£ s. d.	tons cwt.	tons cwt.
50 loads (25 tons) London Dung .	10 0 0	23 0	24 8
25 loads (12½ tons) London Dung .	5 0 0	20 14	20 2
25 loads London Dung, Phosphates, and 4 cwt. Nitrate of Soda	8 2 0	27 3	27 12
25 loads London Dung, Phosphates, and 6 cwt. Nitrate of Soda	9 4 0	—	30 8
No Dung; Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	3 2 0	24 14	—
Do., do., with Potash Salts . .	3 12 0	24 9	—
No Dung; Phosphates (no Potash Salts), and 8 cwt. Nitrate of Soda	5 6 0	—	27 4
Do., do., with Potash Salts . .	5 16 0	—	29 16

Here again the comparatively small effect of heavy dunging is remarkable. On an average of eighteen seasons there is a difference of only 4 tons per acre between the crop produced by the heavy dressing of stable manure and that produced by half the quantity. When, however, the light dressing of stable manure was supplemented by a mixture of

chemical fertilisers consisting of phosphates and 2 cwt. of nitrate of soda per acre, the annual average increase has been from 5 to 6 tons per acre. When the nitrate of soda was increased to 4 cwt. per acre, the increase in crop has been from 7 to 8 tons per acre; and with 6 cwt. of nitrate no less than 10 tons per acre, or nearly three times the increase arrived at by doubling the dung.

When we turn to the second table we find that, in the total absence of dung, phosphates and 4 cwt. of nitrate of soda per acre were able, in the first five years, to produce a larger crop than was produced by the full dressing (50 loads or 25 tons per acre) of stable manure; while during the last eleven years a liberal dressing of phosphates, with potash salts and 8 cwt. per acre of nitrate of soda, has enabled us to grow an average of nearly 30 tons of cabbages per acre, as against an average of about 24½ tons produced by the heavy dressing of stable manure. In fact this plot has been as good on the average as any plot of cabbages on the field.

It will be seen that, while in earlier years, even on the undunged ground, we were able to do without potash salts, their use has later become imperative on land that has been kept continuously without dung; and we consider that, even if not essential, it would be safer, *when dung is dispensed with altogether* for cabbages, to apply potash salts as well as phosphates and nitrogenous manure, at any rate on light land.

RECOMMENDATION as to Manuring of AUTUMN CABBAGES.

As regards practical recommendations we would say that, if dung is used, not more than about 12 tons per acre (or 25 small loads) should be applied for autumn cabbages, supplemented by 6 cwt. of superphosphate, or 8 to 10 cwt. of basic slag per acre, according to the nature of the soil. Three cwt. of nitrate of soda per acre should be sown at about the time at which the cabbages are planted out, and 3 cwt. a month or two later. If the climate happens to be a moist one, the total quantity of 6 cwt. per acre might be divided into three top dressings instead of two. Apart from averages, the experience of individual years appears to indicate that such a moderate quantity of dung as we have mentioned is desirable for this crop, but nevertheless, if dung is scarce, it may very well be intermitted. In that case the phosphatic dressing might be somewhat increased, and should be accompanied by 1 cwt. of sulphate of potash, or 4 cwt. of kainit per acre. If nitrate of soda be the only nitrogenous manure given, the dressing, in the absence of dung, may safely go as far as 8 cwt. per acre.



Crop, 12¼ tons per acre.

Manure per acre—
12½ tons London Dung

(cost £5 per acre).

Crop, 19½ tons per acre.

Manure per acre—
No Dung,
4 cwt. Superphosphate,
4 cwt. Nitrate of Soda

(cost £2 10*s*. per acre).

SAVOY CABBAGES.

We have grown Savoy Cabbages for eighteen seasons on the same plan as the ordinary autumn cabbages just discussed. The results are given in the following tables :—

SAVOY CABBAGES.

PLOTS RECEIVING STABLE MANURE.

Annual manuring per acre.	Average annual cost of manure per acre.	Average annual weight of cabbages per acre.	
		Eighteen seasons.	Last thirteen seasons.
	£ s. d.	tons cwt.	tons cwt.
50 loads (25 tons) London Dung .	10 0 0	23 6	24 17
25 loads (12½ tons) London Dung .	5 0 0	19 2	20 5
25 loads Dung, Phosphates (no Potash Salts) and 2 cwt. Nitrate of Soda	7 0 0	24 6	25 4
Do., do., with Potash Salts . .	7 10 0	25 3	26 0
25 loads Dung, Phosphates (no Potash Salts) and 4 cwt. Nitrate of Soda	8 2 0	26 16	28 1
Do., do., with Potash Salts . .	8 12 0	26 3	28 2
25 loads Dung, Phosphates (no Potash Salts) and 6 cwt. Nitrate of Soda	9 4 0	—	28 1
Do., do., with Potash Salts . .	9 14 0	—	28 18

COMPARISON OF PLOTS WITH AND WITHOUT STABLE MANURE.

Annual manuring per acre.	Average annual cost of manure per acre.	Average annual weight of cabbages per acre.	
		First five seasons.	Last thirteen seasons.
	£ s. d.	tons cwt.	tons cwt.
50 loads (25 tons) London Dung .	10 0 0	16 0	24 17
25 loads (12½ tons) London Dung .	5 0 0	13 7	20 5
25 loads London Dung, Phosphates, and 4 cwt. Nitrate of Soda	8 12 0	19 10	28 1
25 loads London Dung, Phosphates, and 6 cwt. Nitrate of Soda	9 14 0	—	28 1
No Dung; Phosphates (no Potash Salts) and 4 cwt. Nitrate of Soda	3 2 0	17 3	—
Do., do., with Potash Salts . .	3 12 0	16 18	—
No Dung; Phosphates (no Potash Salts) and 8 cwt. Nitrate of Soda	5 6 0	—	26 2
Do., do., with Potash Salts . .	5 16 0	—	27 16

The average weight of this crop is, unless it is closely planted, usually less than that of the large, smooth autumn cabbage, and the differences produced by manuring are sometimes less marked. It will be seen, however, that, as in the case of the autumn cabbages, heavy dunging is an extravagance not warranted by the result produced. The doubling of the dressing of stable manure from 25 to 50 loads per acre has only produced from 4 to 4½ tons of increase, whereas the supplementation of the light dressing of stable manure by suitable chemical fertilisers has produced an increase of as much as 7 to 8 tons per acre. Light dung, supplemented with phosphates and 4 cwt. of nitrate of soda per acre, has given better results than when the quantity of nitrate was restricted to 2 cwt. per acre. When, on the other hand, the nitrate was increased from 4 cwt. to 6 cwt. per acre, the further gain has been small.

Potash, over the whole period, has not produced much effect, taking one year with another, on the dunged plots; but if regard be had to the last eleven seasons, there is on the whole an increase on the potash plots, this increase being, as might be expected, accentuated in the case of the crops grown on ground that is kept without dung. The crops obtained on the plots receiving phosphates, potash salts, and 8 cwt. per acre per annum of nitrate of soda, without dung, have been nearly as heavy as those yielded by the best of the plots manured jointly with dung and similar chemical dressings, and far better than the crops grown with heavy dung unassisted by chemical fertilisers.

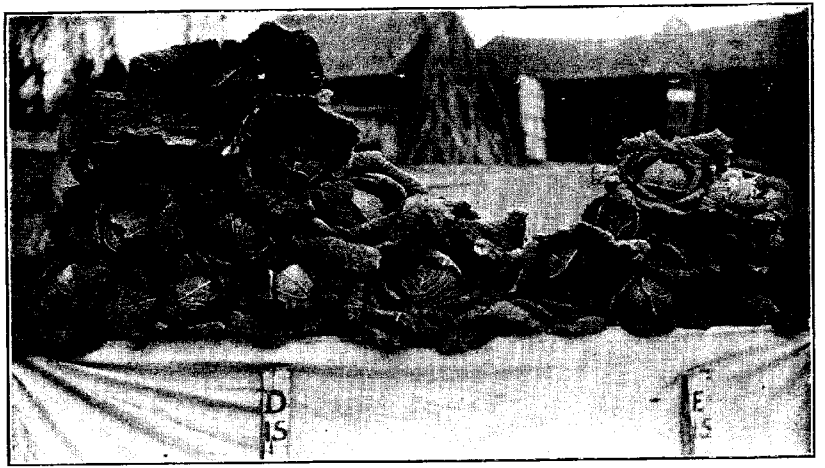
RECOMMENDATION as to Manuring of SAVOY CABBAGES.

As the result of our experience we consider that the most economical manuring for Savoys is probably a light dressing of stable manure accompanied by a good dressing of phosphates (say 6 cwt. per acre of superphosphate, or 8 cwt. per acre of basic slag) with 4 cwt. of nitrate of soda per acre, the nitrate being given in two dressings. But where dung is scarce an excellent crop can be grown with a good phosphatic dressing (6 cwt. of superphosphate, or 8 to 10 cwt. of basic slag per acre) mixed with 1 cwt. of sulphate of potash or 4 cwt. of kainit per acre, well worked into the ground before planting, and followed by 6 to 8 cwt. of nitrate of soda per acre; the nitrate being divided into two dressings in dry localities, or into three dressings in moist ones.

SPRING CABBAGES.

By "Spring Cabbages" we mean the crop sown in late summer, planted out in the autumn, and cut for market in the spring or early summer.

FROM A SPECIMEN CROP OF SAVOY CABBAGES.



Crop, 18 tons 2 cwt. per acre.
Manure per acre—
12½ tons London Dung,
4 cwt. Superphosphate,
4 cwt. Nitrate of Soda
(cost £7 10s. per acre).

Crop, 12 tons 6 cwt. per acre.
Manure per acre—
12½ tons London Dung,
without chemical fertilisers
(cost £5 per acre).

It is the usual practice of market gardeners to apply dung for spring cabbages, even when they follow another crop that has been dunged, and, although we are doubtful as to the general advisability of this course, we have followed the ordinary custom.

We have grown seventeen crops of spring cabbages, and the average results are set forth in the following tables:—

SPRING CABBAGES.

PLOTS RECEIVING STABLE MANURE.

Annual manuring per acre.	Average annual cost of manure per acre.	Average annual weight of cabbages per acre.	
		Seventeen seasons.	Last twelve seasons.
	£ s. d.	tons cwt.	tons cwt.
50 loads (25 tons) London Dung .	10 0 0	19 12	21 6
25 loads (12½ tons) London Dung .	5 0 0	18 18	19 12
25 loads London Dung, Phosphates, and 2 cwt. Nitrate of Soda	7 0 0	20 0	21 7
25 loads London Dung, Phosphates, and 4 cwt. Nitrate of Soda	8 2 0	20 19	22 11
25 loads London Dung, Phosphates, and 6 cwt. Nitrate of Soda	9 4 0	—	23 14

COMPARISON OF PLOTS WITH AND WITHOUT STABLE MANURE.

Annual manuring per acre.	Average annual cost of manure per acre.	Average annual weight of cabbages per acre.	
		First five seasons.	Last twelve seasons.
	£ s. d.	tons cwt.	tons cwt.
50 loads (25 tons) London Dung .	10 0 0	16 2	21 6
25 loads (12½ tons) London Dung .	5 0 0	15 12	19 12
25 loads London Dung, Phosphates, and 4 cwt. Nitrate of Soda	8 2 0	17 4	22 11
25 loads London Dung, Phosphates, and 6 cwt. Nitrate of Soda	9 4 0	—	23 14
No Dung; Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	3 2 0	16 13	—
Do., do., with Potash Salts . .	3 12 0	17 14	—
No Dung; Phosphates (no Potash Salts), and 8 cwt. Nitrate of Soda	5 6 0	—	22 0
Do., do., with Potash Salts . .	5 16 0	—	23 15

As in the case of autumn cabbages, we have on the average observed no benefit from the use of potash salts on the plots to which stable manure has been applied, and we therefore, in these cases, omit the results obtained on the plots receiving potash salts.

Having regard first to the plots receiving stable manure, we see that the doubling of the smaller dressing of stable manure only added, on the average, from 1 to 2 tons per acre to the weight of the crop. Better results were obtained by adding to the smaller dressing of stable manure a dressing of phosphates, accompanied by as little as 2 cwt. per acre of nitrate of soda. By increasing the nitrate of soda to 4 cwt. per acre, about another ton of cabbages per acre has been gained, this increase being further raised by yet another ton when we use 6 cwt. of nitrate of soda per acre

It will be observed, however, that, provided potash salts are used, chemical fertilisers alone have produced a better crop than we have been able to grow by means of heavy dung alone, and as good a crop as we have been able to grow with light dung and chemical fertilisers together.

For ordinary autumn cabbages a light dressing of dung, even when plenty of phosphates and nitrate are used, appears to be of distinct advantage; and this would seem to be also the case with Savoys. On the other hand, however, no tangible advantage appears to be derived from applying a special dressing of dung for *Spring* Cabbages. One reason for the difference, probably, is that the life of the ordinary autumn cabbage is confined to the summer and autumn. Its growth thus takes place during the hottest months of the year. The mechanical effects of dung in retaining moisture, therefore, during dry weather—apart from the fertilising value that it possesses—may often be of great utility to this crop, especially in dry districts.

The spring cabbage, however, is planted out in the autumn, and makes little growth until the growing season sets in in the spring. It is, therefore, not so likely to suffer to any great extent from drought in its early stages, its principal enemy, indeed, being the cold of the winter. Then its active growth, when it does begin, takes place during the late spring and early summer; and here again, having already established itself, it is less likely to suffer from drought than the other kinds of cabbages that are planted out in the summer.

It also seems possible that dung, when applied to autumn-planted cabbages, may feed the plant too much in its early stages. As has been already pointed out, all that the crop has to do during the cold of winter

SAVOY CABBAGES.

Manure per acre—
12½ tons London Dung,
6 cwt. Superphosphate,
6 cwt. Nitrate of Soda
(cost £8 15*s.* per acre).

No Dung,
6 cwt. Superphosphate,
8 cwt. Nitrate of Soda,
1 cwt. Sulphate of Potash
(cost £5 5*s.* per acre).



Manure per acre—
25 tons London Dung
(cost £10 per acre).

12½ tons London Dung
(cost £5 per acre).

is to keep alive, and all that is really needed, in order to give it a good chance of welfare, appears to be to get it well established before the winter sets in. But it seems desirable that the young plant should not be too advanced in its growth at this early stage.

Should the winter chance to be mild and open, doubtless early forwardness of growth may prove to be an advantage in bringing on early maturity; but if the winter happens to be long or hard, an early advance in growth may be a positive disadvantage, rendering the plant less able to stand the perils of frost. Plants that are killed or crippled by frost during the winter have to be replaced by successors transplanted from a reserve seed-bed, which is necessarily crowded; and they will be poor, stunted plants as compared with those that had become properly rooted in the open space of the field. Moreover, it takes such plants some time to recover from the process of unseasonable transplantation in the spring instead of in the autumn.

RECOMMENDATION as to Manuring of SPRING CABBAGES.

It will probably, therefore, be found best not to apply dung directly for spring cabbages, but to plant them out *after the removal of some other crop that has been dunged*, giving a liberal dressing of superphosphate (say 6 cwt. per acre) or other phosphatic manure that may be selected. A dressing of 1 cwt. of sulphate of potash or 4 cwt. of kainit per acre will probably be useful on light soils, or on soils that are not in high condition from the previous use of dung. This should be well mixed into the ground before planting, at the same time as the phosphatic manure. Nitrate of soda may be used at the rate of 4 cwt. per acre, applied in the spring. If dung is used, or if the land happens to have been liberally dunged early in the year for the previous crop, this will probably produce a good crop; but if more than one crop has intervened since dung was applied, the nitrate might advantageously be increased to 6 cwt. per acre, divided into two dressings.

RED CABBAGES.

We have made use of another odd corner of the field to try the effect of growing Red Cabbages with dung and chemical fertilisers, with and without nitrate of soda. Both plots have received 25 loads of stable manure per acre, with a dressing of phosphates (superphosphate and basic slag alternately) and 1 cwt. of sulphate of potash per acre. One of the plots has received in addition 4 cwt. of nitrate of soda per acre. In this way we have grown, between 1902 and 1912, nine crops, the average results being as follows :—

RED CABBAGES.

Annual manuring per acre.	Average annual cost of manure per acre.	Average annual weight of cabbages per acre. Nine seasons.
	£ s. d.	tons cwt.
25 loads (12½ tons) London Dung, Phosphates, and Potash Salts (no Nitrate of Soda)	6 8 0	17 0
25 loads (12½ tons) London Dung, Phosphates, Potash Salts, and 4 cwt. Nitrate of Soda	8 12 0	23 15

BRUSSELS SPROUTS.

This is one of the most important crops of the market gardener, and one very heavily affected by manuring. Extensive areas of Brussels sprouts are grown every autumn in the market gardens near our great cities, and for the growth of these crops large sums of money are annually spent in the purchase of town stable manure. Our experiments clearly indicate that such purchases are both extravagant and unnecessary. If stable manure be used at all for sprouts—for which there is no essential need—it would be more economical to use less than is usual; but, as will be seen from the results of our experience, sprouts may be more profitably grown without any direct application of stable manure, if liberal recourse be had to common concentrated fertilisers.

We are able to record the results of eighteen crops of Brussels Sprouts, grown, as in the case with the great majority of our crops, in rotation with other vegetables in accordance with ordinary market garden practice. We have thought it convenient to record the results, which are shown in the following tables, in terms of "sieves" per acre—a "sieve" being the well-recognised English market term for a weight of 40 lbs. of sprouts.

BRUSSELS SPROUTS.

PLOTS RECEIVING STABLE MANURE.

Annual manuring per acre.	Average annual cost of manure per acre.	Average annual yield of sprouts per acre.	
		Eighteen seasons.	Last thirteen seasons.
	£ s. d.	Sieves.	Sieves.
50 loads (25 tons) London Dung .	10 0 0	272	269
25 loads (12½ tons) London Dung .	5 0 0	212	199
25 loads Dung, Phosphates (no Potash Salts), and 2 cwt. Nitrate of Soda	7 0 0	267	255
Do., do., with Potash Salts . .	7 10 0	264	248
25 loads Dung, Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	8 2 0	285	282
Do., do., with Potash Salts . .	8 12 0	290	280
25 loads Dung, Phosphates (no Potash Salts), and 6 cwt. Nitrate of Soda	9 4 0	—	296
Do., do., with Potash Salts . .	9 14 0	—	284

COMPARISON OF PLOTS WITH AND WITHOUT STABLE MANURE.

Annual manuring per acre.	Average annual cost of manure per acre.	Average annual yield of sprouts per acre.	
		First five seasons.	Last thirteen seasons.
	£ s. d.	Sieves.	Sieves.
50 loads (25 tons) London Dung .	10 0 0	279	269
25 loads (12½ tons) London Dung .	5 0 0	244	199
25 loads Dung, Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	8 2 0	293	282
Do., do., with Potash Salts . .	8 12 0	318	280
No Dung; Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	3 2 0	260	—
Do., do., with Potash Salts . .	3 12 0	292	—
No Dung; Phosphates (no Potash Salts), and 8 cwt. Nitrate of Soda	5 6 0	—	251
Do., do., with Potash Salts . .	5 16 0	—	274

In the first place, we may turn our attention to the results chronicled in the upper table, namely, those obtained on the plots receiving stable manure.

The first point that strikes us, whether we regard the whole series of eighteen seasons or the last series of thirteen seasons, is that, if we take the lightly dunged plot as a basis of comparison, the yield obtained by doubling the dung is substantially less than that obtained by supplementing the smaller dressing of dung with chemical fertilisers, provided that the concentrated nitrogenous manure given is not less than that afforded by 4 cwt. of nitrate of soda per acre. It will also be seen, from the experience of the last thirteen seasons, that no practical advantage appears to attach to increasing the quantity of nitrate of soda beyond 4 cwt. when a light dressing of dung is used. Furthermore, it will be noticed that, when dung is used, the special application of potash salts does not appear to have been of any use in the case of this crop, which seems to resemble autumn cabbages in its faculty for availing itself of a supply of potash which for many other crops is insufficient.

Let us now pass on to the consideration of the second table, in which are included the results obtained without the use of stable manure.

In the first five years, in which the dressing of nitrate on the undunged plots was restricted to 4 cwt. per acre, in combination with phosphates and potash salts, the result obtained was not so good as when the same dressing of chemical fertilisers was given in addition to a small dressing of stable manure; but the result was very substantially better than that obtained by doubling the dressing of stable manure. The fully chemically manured plot showed an average advantage of 48 "sieves" per acre. This, at 1*s.* 6*d.* per "sieve," comes to £3 12*s.* per acre. In addition there was an annual saving of £6 8*s.* in the cost of manuring, making a total average advantage, over five years, of £10 per acre in favour of the chemical dressing as against the heavy dunging.

Coming to the last thirteen seasons, it must be borne in mind that the various plots on which the undunged crop has been grown have been kept *continuously* without dung during the whole of the experimental period, and indeed for some time previously; and as such plots lose the mechanical advantage derived from even an occasional application of dung to intermediate crops, they afford a somewhat extreme object lesson, which, however, becomes for that reason all the more instructive. Here again the crop has not been quite so good as the crop grown by the annual use of chemical fertilisers accompanied by the continuous use of a small quantity of dung; but it is better by 5 "sieves" (worth, say, 7*s.* 6*d.*) than the yield of the heavily dunged plot. It has only cost, however, for manuring, £5 16*s* per acre, as against £10 for the heavily dunged plot, so that, even in the continuous absence of dung, there has been

BRUSSELS SPROUTS (average yield of five Seasons).



291 Sieves (of 40 lb.) per acre.

Manure per acre—

No Dung, Phosphates, Potash Salts, and 4 cwt. Nitrate of Soda

(cost £3 5s. per acre).

269 Sieves (of 40 lb.) per acre.

Manure per acre—

25 tons London Dung, without chemical fertilisers

(cost £10 per acre).

an advantage of £4 11s. 6d. per acre in favour of the chemical fertilisers. In fact, having regard to the yield as well as the cost of manuring, this plot has been the most remunerative of the series.

It will be observed that potash salts have produced, on the average, a substantial effect on the plots to which no dung has been applied.

RECOMMENDATION as to Manuring of BRUSSELS SPROUTS.

While, on the whole, our experiments point to the general desirability in market gardening of moderate dunging, supplemented by chemical fertilisers, Brussels sprouts appear to be essentially a crop to which it is extravagant to apply dung directly at all. In the ordinary market garden there will be in every field in every season the residual dung of previous years, and our general advice to the market gardener with regard to Brussels sprouts would be to use no dung beyond what is already left in the ground unconsumed by previous crops, but for the immediate manuring of the sprouts to rely wholly upon chemical fertilisers. Six cwt. of superphosphate, or 8 cwt. of basic slag, and 4 cwt. of kainit per acre—or other phosphatic and potash dressings equivalent thereto—should be well incorporated in the soil before the plants are set. As soon as the plants are established, from 2 to 3 cwt. per acre of nitrate of soda should be sown between the rows, and an additional dressing of from 2 to 3 cwt. per acre should be applied a month later. We can confidently predict that in this way the market gardener will grow a larger quantity of sprouts than he would with a dressing of even 50 loads (25 tons) of stable manure per acre without the aid of chemical fertilisers, and he will at the same time effect a large saving in the cost of manuring. In formulating this recommendation we have in mind, as usual, a soil of heavy or medium consistency. On a light sandy or gravelly soil, the direct use of a light dressing of stable manure would no doubt be advantageous for this as for other crops, for mechanical or physical reasons.

SUMMER LETTUCES.

We have not been able to grow these so frequently as some of our crops, owing to misfortunes (chiefly due to drought and wire-worm) in the early stages of growth, which have often prevented our getting a sufficiently regular plant for experimental purposes. We have, however, the results of seven seasons, which are set forth in the tables on page 56.

It will be noticed that in the later seasons the plants have been much

SUMMER LETTUCES.

PLOTS RECEIVING STABLE MANURE.

Annual manuring per acre.	Average annual cost of manure per acre.	Seven crops. Average gross annual weight of lettuces per acre.	Seven crops. Average weight per lettuce.	Last three crops. Average gross annual weight of lettuces per acre.	Last three crops. Average weight per lettuce.
	£ s. d.	tons cwt.	ozs.	tons cwt.	ozs.
50 loads (25 tons) London Dung	10 0 0	19 14	17·4	31 5	28·0
25 loads (12½ tons) London Dung	5 0 0	14 18	13·0	22 1	19·9
25 loads London Dung, Phosphates (no Potash Salts), and 2 cwt. Nitrate of Soda	7 0 0	18 1	15·7	26 2	22·8
Do., do., with Potash Salts	7 10 0	17 15	15·6	26 3	23·2
25 loads London Dung, Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	8 2 0	18 15	16·4	27 14	24·5
Do., do., with Potash Salts	8 12 0	19 3	16·7	28 13	25·3
25 loads London Dung, Phosphates (no Potash Salts), and 6 cwt. Nitrate of Soda	9 4 0	—	—	28 7	25·1
Do., do., with Potash Salts	9 14 0	—	—	30 2	26·5

COMPARISON OF PLOTS WITH AND WITHOUT STABLE MANURE.

Annual manuring per acre.	Average annual cost of manure per acre.	First four crops. Average gross annual weight of lettuces per acre.	First four crops. Average weight per lettuce.	Last three crops. Average gross annual weight of lettuces per acre.	Last three crops. Average weight per lettuce.
	£ s. d.	tons cwt.	ozs.	tons cwt.	ozs.
50 loads (25 tons) London Dung	10 0 0	11 1	9·5	31 5	28·0
25 loads (12½ tons) London Dung	5 0 0	9 3	7·8	22 1	19·9
25 loads Dung, Phosphates, and 2 cwt. Nitrate of Soda	7 0 0	12 0	10·3	26 2	22·8
25 loads Dung, Phosphates, and 4 cwt. Nitrate of Soda	8 2 0	12 1	10·4	27 14	24·5
25 loads Dung, Phosphates, and 6 cwt. Nitrate of Soda	9 4 0	—	—	28 7	25·1
No Dung; Phosphates (no Potash Salts) and 4 cwt. Nitrate of Soda	3 2 0	10 9	9·0	—	—
Do., do., with Potash Salts	3 12 0	10 17	9·3	—	—
No Dung; Phosphates (no Potash Salts) and 8 cwt. Nitrate of Soda	5 6 0	—	—	16 12	14·6
Do., do., with Potash Salts	5 16 0	—	—	23 19	21·1

heavier than in the earlier ones. This is to be attributed to greater prevalence of dry weather during the earlier period.

The light dressing of stable manure (25 loads or 12½ tons per acre) has produced only a comparatively small crop, and a large increase has been obtained by the use of double this quantity of stable manure, the heavily dunged plot being on the whole the best of the series. A satisfactory crop can, however, be grown with the lighter dressing of stable manure supplemented by a liberal application of phosphates and nitrate of soda up to 4 cwt. per acre.

On the dunged plots potash has, on the whole, produced no substantial effect. Such differences as occurred between the potash and non-potash plots appear, on examination of the various years' results in detail, to be only such as might be due to chance variations.

Turning to the second table, where the plots kept continuously without dung are compared with the dunged plots, it will be seen that in the earlier seasons, when the crops were small, the plot dressed with chemical fertilisers only was nearly equal to the best of the other plots; but in the later seasons, when the yield was more abundant, the plots receiving chemical fertilisers alone, although dosed with increased liberality, were much behind the dunged plots.

During later seasons, potash, as might be expected, has told heavily on the yield of lettuces on the continuously undunged plots, this difference having been marked in each season.

RECOMMENDATION as to Manuring of SUMMER LETTUCES.

Summer Lettuces should not be left without dung, lest they may suffer from drought early in the season. A heavy dressing of dung (50 loads or 25 tons per acre) appears to produce a full yield, but good results may be looked for, at a substantial saving in cost, if half this quantity of dung be given, with 4 to 6 cwt. of superphosphate and 4 cwt. of nitrate of soda per acre, 2 cwt. of the nitrate being sown when the plant is thinned out, and 2 cwt. a few weeks later. It will be noticed that in our earlier seasons, when the lettuces were small all round, 4 cwt. of nitrate of soda per acre did no better than 2 cwt., and we were then disposed to recommend 2 cwt. per acre as a general application for this crop. In our more recent seasons, however, when the lettuces have been very much larger, not only has 4 cwt. of nitrate per acre done better than 2 cwt., but 6 cwt. has done better still. Taking one season with another, we are now disposed to recommend 4 cwt. of nitrate of soda per acre, or its equivalent, for this crop.

WINTER LETTUCES.

Of Winter Lettuces we have grown twelve crops.

As winter lettuces are planted out in the autumn, on ground from which another crop has just been taken, we have followed the ordinary market garden practice of not applying another dressing of stable manure specially for this crop. In the following summary of our results, therefore, it should be carefully noted that the dung mentioned was applied, not directly to the lettuces, but to the immediately preceding crop.

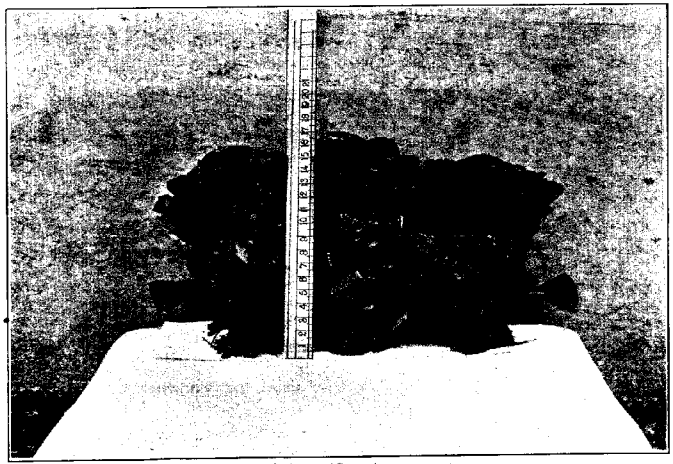
PLOTS RECEIVING STABLE MANURE (FOR PREVIOUS CROP).

Annual manuring per acre.	Average annual cost of chemical fertilisers per acre.	Twelve seasons. Average gross annual weight of lettuces per acre.	Twelve seasons. Average weight per lettuce.	Last eight seasons. Average gross annual weight of lettuces per acre.	Last eight seasons. Average weight per lettuce.
	£ s. d.	tons cwt.	ozs.	tons cwt.	ozs.
50 loads (25 tons) London Dung (*applied to previous crop*)	—	15 11	21·0	17 3	24·2
25 loads (12½ tons) London Dung (*applied to previous crop*)	—	13 3	17·8	14 10	20·7
25 loads London Dung (*to previous crop*), Phosphates (no Potash), and 2 cwt. Nitrate of Soda	2 0 0	17 7	21·3	17 11	25·2
Do., do., with Potash	2 10 0	15 18	21·6	17 8	25·3
25 loads London Dung (*to previous crop*), Phosphates (no Potash), and 4 cwt. Nitrate of Soda	3 2 0	14 16	20·0	16 6	23·4
Do., do., with Potash	3 12 0	15 15	21·4	17 2	24·9
25 loads London Dung (*to previous crop*), Phosphates (no Potash), and 6 cwt. Nitrate of Soda	4 4 0	—	—	16 12	23·7
Do., do., with Potash	4 14 0	—	—	17 16	25·4

COMPARISON OF PLOTS WITH AND WITHOUT PREVIOUS DRESSINGS OF STABLE MANURE.

Annual manuring per acre.	Average annual cost of manure per acre.	First four years. Average gross yearly weight of lettuces per acre.	First four years. Average weight per lettuce.	Last eight years. Average gross annual weight of lettuces per acre.	Last eight years. Average weight per lettuce.
	£ s. d.	tons cwt.	ozs.	tons cwt.	ozs.
50 loads (25 tons) London Dung (*applied to previous crop*)	—	12 17	14·2	17 3	24·2
25 loads (12½ tons) London Dung (*applied to previous crop*)	—	10 8	11·9	14 10	20·7
No Dung for many years; Phosphates (no Potash) and 4 cwt. Nitrate of Soda	3 2 0	9 17	11·4	—	—
Do., do., with Potash	3 12 0	10 2	11·8	—	—
No Dung for many years; Phosphates (no Potash) and 8 cwt. Nitrate of Soda	5 6 0	—	—	10 15	15·5
Do., do., with Potash	5 16 0	—	—	14 3	20·2

WINTER LETTUCE, 1900-1901.



Crop, 13 tons 19 cwt. per acre.
Weight of three Lettuce, 7 lbs.

Manure per acre—
4 cwt. Nitrate of Soda,
4 cwt. Superphosphate of Lime,
1 cwt. Sulphate of Potash
(cost about £3 per acre).

On the whole, the best results are those obtained on the land heavily dunged for the preceding crop, although it should be noted that in nearly every one of the seasons here averaged some one or other of the other plots gave better results.

Next in order of immediate economy are the results obtained on the land to which a light dressing of dung was applied for the previous crop, the lettuces being dressed with phosphates and 2 cwt. of nitrate of soda per acre. There appears to have been, on the whole, no advantage in increasing this quantity of nitrate.

The lettuces grown on the continuously undunged plots were inferior in size. On these plots potash salts have produced a very marked effect, but not on the land to which dung has been intermittently applied.

RECOMMENDATION as to Manuring of WINTER LETTUCES.

Although it appears from these experiments that, if the extravagance of heavy dunging (at the rate of 50 loads per acre) has been committed for the previous crop, winter lettuces following that crop need not be further manured, it is yet to be remembered that in the case of most crops our trials show that such heavy dunging is unprofitable for the main crop to which it is applied. It appears to us, therefore, that we should rather consider as normal the case in which the most prudent mode of manuring has been previously followed, namely, the application of a light dressing of dung supplemented by chemical fertilisers. In that case the winter lettuce may be planted without further dung, a dressing of 4 cwt. of superphosphate per acre being applied before planting out, followed by a top dressing of 2 cwt. of nitrate per acre in the early spring.

GLOBE (OR THISTLE-HEADED) ARTICHOKES.

We have made several plantations of Globe (or thistle-headed) Artichokes, that is to say, the artichokes the heads or buds of which constitute the edible portion. These plants are not to be confused with the Jerusalem Artichoke, grown for its tuberous roots.

Our first plantation was the most successful. Some of the subsequent plantations were of shorter life, owing to the dying off of plants through unfavourable weather.

The following table shows the average produce of the plots of chief interest. The plots to which no stable manure at all was applied, but only chemical fertilisers, gave such comparatively unsatisfactory results

that little interest attaches to them beyond the conclusion that this crop cannot, apparently, be grown properly without the use of dung, either continuous or intermittent.

GLOBE (OR THISTLE-HEADED) ARTICHOKES.

PLOTS RECEIVING STABLE MANURE.

Annual manuring per acre.	Average annual cost of manure per acre.	Average annual yield per acre from **eight crops.**			
		Total heads.	Early heads.	Gross weight.	Average weight per head.
	£ s. d.			tons cwt.	ozs.
50 loads (25 tons) London Dung	10 0 0	18,670	11,380	4 2	7·9
25 loads (12½ tons) London Dung	5 0 0	13,460	7,830	3 2	8·3
25 loads London Dung, Phosphates (no Potash Salts), and 2 cwt. Nitrate of Soda	7 0 0	16,550	10,120	3 15	8·0
Do., do., with Potash Salts	7 10 0	17,640	10,830	4 0	8·2
25 loads London Dung, Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	8 2 0	16,310	8,640	3 15	8·3
Do., do., with Potash Salts	8 12 0	19,770	11,930	4 10	8·1

It will be seen from the last column of the table that the average size of the heads has been but little affected by the method of manuring, but that the number and earliness of the heads has been largely influenced.

Next to the column giving the average number of total heads is a column giving the average number of "early" heads. Early maturity is a matter of importance with regard to this crop, as far as market purposes are concerned. For instance, there is a large demand for globe artichokes during what is called the "London season," and there is then little difficulty in disposing of the heads at good prices in the London market. Some time in July, however, the demand so falls off that the heads are no longer saleable in the principal markets at prices remunerative to the grower, who has to pay carriage and other sale expenses. It is therefore important, in the case of this particular crop, if we are to appreciate the full effect of the different systems of manuring, to regard not only the total number of heads cut during the season, but also the proportion which is produced in the earlier part of it, when the produce is in demand. On this account we have differentiated between the total

number of heads cut and those cut before what may be called the "closing of the market," in July. On looking down the figures, the first thing obvious is that the plots receiving 25 loads of dung per acre only have been under-manured, a much greater yield, both of total and "early" heads, having been produced by the 25 extra loads of dung on the heavily dunged plot, and also by the various mixtures of chemical fertilisers applied in addition to the smaller quantity of dung on the other plots. If in each case we deduct the yield obtained with 25 loads of dung alone, we shall be able better to appreciate the increase produced, on the one hand by the extra dung, and on the other hand by the chemical fertilisers. This is shown in the following table:—

GLOBE ARTICHOKES.

Manure annually applied, in addition to 25 loads London dung per acre.	Average annual cost of extra manure per acre.	Average EXTRA yield of globe artichokes per acre, due to extra manure in excess of 25 loads London dung per acre. (Eight seasons.)		
		Annual increase in "early" heads per acre.	Annual increase in total heads per acre.	Annual increase in weight per acre.
	£ s. d.			tons. cwt.
25 extra loads Dung (50 in all)	5 0 0	3,559	5,210	1 0
Phosphates and 2 cwt. Nitrate of Soda (no Potash Salts)	2 0 0	2,290	3,090	0 13
Do., do., with Potash Salts	2 10 0	3,000	4,180	0 18
Phosphates and 4 cwt. Nitrate of Soda (no Potash Salts)	3 2 0	810	2,850	0 13
Do., do., with Potash Salts	3 12 0	4,100	6,310	1 8

It will be seen that the chemical dressings when used as an auxiliary to a light dressing of dung—except where potash salts have been omitted—have given on the average a larger increase in total heads than has the extra dung, and that the increase is very marked in the case of the "early" heads.

It is interesting to note the effect of potash on this crop. Whether we regard the total heads or the "early" heads, the effect of omitting potash salts on the chemically dressed plots has been to prevent the phosphates and nitrate (even in the presence of a moderate quantity of dung) from increasing the crop to anything like the extent to which they were able to increase it when reinforced by potash salts.

The extra 25 loads of dung per acre, which has proved the least satisfactory form of additional manuring, cost, it will have been seen, £5. The chemical dressings on the best plot cost on the average £3 12*s.*, showing a saving of £1 8*s.* per acre. The latter produced an average of 550 more "early" heads, or say 40 "market" dozen. The price we have actually received for our artichokes has varied from as little as 6*d.* to as much as 2*s.* 6*d.* per dozen, and in one year averaged as much as 1*s.* 5*d.* after deduction of cost of carriage and sale expenses. If, however, we take the value at only 1*s.* per dozen, the 40 extra dozen of "early" heads would, at that rate, be worth £2, which, added to the saving of £1 8*s.* in the cost of manuring, makes an advantage of £3 8*s.* per acre due to the partial substitution of chemical fertilisers for dung. This is an average result over eight seasons, but in one season, when our best plantation was in its second year of bearing, the advantage actually obtained by the partial substitution of chemical fertilisers for dung was at the rate of something like £15 an acre!

We have tried larger dressings of nitrate of soda than 4 cwt. per acre, in addition to dung, etc., but thus far without advantage.

RECOMMENDATION as to Manuring of GLOBE ARTICHOKES.

We consider that a good dressing for globe or thistle-headed artichokes is probably about 25 loads (12 to 13 tons) of dung per acre, with 4 to 6 cwt. of superphosphate, 1 cwt. of sulphate of potash (or 4 cwt. of kainit), and 4 cwt. of nitrate of soda per acre. Where the soil is already in good condition, 2 cwt. of nitrate will probably suffice, but on naturally "hungry" soil, or after a wet winter which has depleted the soil of its natural nitrates, ¾ cwt. will be a safe application.

JERUSALEM ARTICHOKES.

THESE are the ordinary tuberous-rooted Artichokes, of which we have grown eighteen crops. Following general market garden practice, we have grown these every year without any direct application of dung, but on land dunged for the preceding crop, except as regards the plots which on every section are permanently left without stable manure. Our results are shown in the tables on the opposite page.

The plot heavily dunged the year before, has, on the whole, done best; but the plots lightly dunged the year before, and specially manured for the artichokes with phosphates, potash salts and a light dressing of nitrate of soda, have produced good results. When even a light dressing

JERUSALEM ARTICHOKES.

PLOTS RECEIVING STABLE MANURE (FOR PREVIOUS CROP).

Manuring per acre.	Average annual cost of chemical fertilisers.	Average annual weight of roots or tubers per acre.	
		Eighteen seasons.	Last thirteen seasons.
	£ s. d.	tons cwt.	tons cwt.
50 loads (25 tons) London Dung (*applied to previous crop*) . .	. .	13 6	14 10
25 loads (12½ tons) London Dung (*applied to previous crop*) . .	. .	11 6	12 14
25 loads London Dung (*to previous crop*), Phosphates, and 2 cwt. Nitrate of Soda (no Potash Salts)	2 0 0	11 11	12 4
Do., do., with Potash Salts . .	2 10 0	12 15	13 12
25 loads London Dung (*to previous crop*), Phosphates, and 4 cwt. Nitrate of Soda (no Potash Salts)	3 2 0	11 15	12 11
Do., do., with Potash Salts . .	3 12 0	12 13	13 13
25 loads London Dung (*to previous crop*), Phosphates, and 6 cwt. Nitrate of Soda (no Potash Salts)	4 4 0	. .	12 16
Do., do., with Potash Salts . .	4 14 0	. .	13 16

COMPARISON OF PLOTS WITH AND WITHOUT PREVIOUS DRESSINGS OF STABLE MANURE.

Manuring per acre.	Average annual cost of chemical fertilisers.	Average annual weight of roots or tubers per acre.	
		First five seasons (1894–1898).	Last thirteen seasons.
	£ s. d.	tons cwt.	tons cwt.
50 loads (25 tons) London Dung (*applied to previous crop*) . .	. .	10 2	14 10
25 loads (12½ tons) London Dung (*applied to previous crop*) . .	—	7 12	12 14
25 loads London Dung (*to previous crop*), Phosphates, Potash Salts, and 2 cwt. Nitrate of Soda	2 10 0	10 10	13 12
No Dung for many years; Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	3 2 0	7 10	—
Do., do., with Potash Salts . .	3 12 0	9 18	—
No Dung for many years; Phosphates (no Potash Salts), and 8 cwt. Nitrate of Soda	5 6 0	—	9 1
Do., do., with Potash Salts . .	5 16 0	—	11 17

of dung has been applied for the previous crop, no advantage seems to have been derived from increasing the nitrate of soda beyond 2 cwt. per acre.

Even on continuously undunged ground, good crops can be raised by means of a liberal dressing of chemical fertilisers; but a smaller dressing of chemical fertilisers, on land lightly dunged for the preceding crop, appears to be more economical.

Potash salts produced a marked effect on this crop. This is particularly conspicuous on the continuously undunged plots, but is also noticeable in the results obtained on the recently dunged plots.

RECOMMENDATION as to Manuring of JERUSALEM ARTICHOKES.

The results on the whole appear to indicate that, if the market gardener has been extravagant enough to use as much as 50 loads (or 25 tons) of dung per acre for any other crop, and wishes subsequently to grow Jerusalem Artichokes, he had better plant them on the same ground without further manuring, since, on the whole, land thus manured has yielded with us better results than were obtained by direct manuring. It is true that in individual years an advantage has been shown by the plots lightly dunged during the previous year and subsequently treated with chemical fertilisers, but the increase was not sufficient to substantially affect the average of years. It must again, however, be borne in mind that the result of our work on the whole is to indicate that heavy dunging of this kind is, for most crops, wasteful, and that as a rule a lighter dressing of dung, supplemented by chemical fertilisers, is the best application. When land is farmed on this principle, it would appear that the most economical way of manuring Jerusalem Artichokes is to apply a dressing of phosphates (say 4 to 6 cwt. of superphosphate per acre), with 1 cwt. per acre of sulphate of potash (or 4 cwt. of kainit), giving a top dressing of 2 cwt. of nitrate of soda per acre. The sulphate of potash or kainit should not be omitted.

CARROTS.

Our custom in manuring Carrots also has been to apply no dung directly to the crop, but to grow the carrots in succession to a crop that has been already dunged. This is in accord with the most generally recognised practice among growers. The question, therefore, which we have set ourselves to answer, is mainly whether, when carrots are grown after a dunged crop, but without receiving dung themselves, it is or is not economical to treat them with chemical fertilisers, and if so what are the best dressings to use?

We have also each year included plots from which dung has been continuously withheld, chemical fertilisers only being applied.

Altogether we have grown fourteen crops of Carrots, the variety usually being of the "stump-rooted" or "intermediate" type. The following tables show the results.

CARROTS.

PLOTS RECEIVING STABLE MANURE (FOR PREVIOUS CROP).

Annual manuring per acre.	Average annual cost of chemical fertilisers per acre.	Average annual weight of carrots per acre.	
		Fourteen seasons.	**Last eleven seasons.**
	£ s. d.	tons cwt.	tons cwt.
50 loads (25 tons) London Dung (*applied to previous crop*) . .	—	14 14	14 17
25 loads (12½ tons) London Dung (*applied to previous crop*) . .	—	12 1	11 16
25 loads London Dung (*to previous crop*), Phosphates (no Potash Salts), and 2 cwt. Nitrate of Soda	2 0 0	11 19	10 18
Do., do., with Potash Salts . .	2 10 0	14 2	12 18
25 loads London Dung (*to previous crop*), Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	3 2 0	13 1	12 2
Do., do., with Potash Salts . .	3 12 0	14 2	13 2
25 loads London Dung (*to previous crop*), Phosphates (no Potash Salts), and 6 cwt. Nitrate of Soda	4 4 0	—	13 4
Do., do., with Potash Salts . .	4 14 0	—	13 15

COMPARISON OF PLOTS WITH AND WITHOUT PREVIOUS DRESSINGS OF STABLE MANURE.

Annual manuring per acre.	Average annual cost of chemical fertilisers per acre.	Average annual weight of carrots per acre.	
		First three seasons.	**Last eleven seasons**
	£ s. d.	tons cwt.	tons cwt.
50 loads (25 tons) London Dung (*applied to previous crop*) . .	—	14 13	14 17
25 loads (12½ tons) London Dung (*applied to previous crop*) . .	—	13 5	11 16
No Dung for many years; Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	3 2 0	11 9	—
Do., do., with Potash Salts . .	3 12 0	16 9	—
No Dung for many years; Phosphates (no Potash Salts), and 8 cwt. Nitrate of Soda	5 6 0	—	7 2
Do., do., with Potash Salts . .	5 16 0	—	11 2

Probably the first point that will strike the reader is the marked influence of potash on this crop. This is extraordinarily noticeable in the results obtained on the continuously undunged land, especially on the average of the last eleven seasons, but it is also marked on the various plots to which dung has been applied regularly. As the result of these experiments, carrots must be noted as among the crops which are unable to obtain a sufficiency of potash under circumstances in which plants of the cabbage tribe are able to take up almost as much potash as they need without artificial assistance.

In the earlier years of our experiments we found that the residue of even so heavy a dunging as fifty loads of stable manure per acre, applied to the previous crop, was insufficient to grow a full crop of carrots. In more recent years, however, on the plots which had been frequently dressed to this heavy extent, the crop has done very well. Where only half this quantity of dung has been used for the previous crop, the residue has been insufficient to grow full crops, but the application of phosphates, potash salts, and nitrate of soda, has answered well. In most seasons 2 cwt. per acre of nitrate appears to be sufficient, though occasionally heavier dressings have produced better results. In seasons in which the weather is favourable for the early growth of the plant, excellent crops of carrots can be raised by the use of chemical fertilisers alone, even on land that has not been dunged for a number of years; but in dry seasons the results are not so good as on land that has been dunged the previous year.

RECOMMENDATION as to Manuring of CARROTS.

If there happens to be on the farm a field to which the grower has in the previous year given a dressing of stable manure amounting to 50 loads, or 25 tons per acre, such land will probably produce a full crop of carrots without any additional manuring, provided that the soil be not of a too hot, open, or gravelly character. On land that has been only moderately dunged for the preceding crop, carrots may be grown satisfactorily without any further dressing of dung, if they receive a dressing of phosphates (say 4 to 6 cwt. of superphosphate, or 8 cwt. of basic slag per acre), with 1 cwt. of sulphate of potash, or 4 cwt. of kainit per acre, and a dressing of nitrate of soda. The phosphates and potash salts should be well incorporated with the soil before sowing. At about the time of hoeing out, 2 cwt. of nitrate of soda per acre may be sown as a top dressing between the rows. In some seasons, especially on light soil and following a wet winter, a further top dressing of 2 cwt. of nitrate of soda per acre may be given

with advantage a month later. Potash salts should on no account be omitted from the initial dressing.

PARSNIPS.

PARSNIPS, which, both botanically and as to their manner of growth, are closely allied to carrots, have been grown on the same principle, namely, without any direct application of stable manure, but following a crop to which such manure has been applied—there being included, however, plots which have previously had no dung. The results are set out in the tables on the next page.

The Parsnip resembles the carrot in regard to its inability to obtain from the ground, or from moderate dressings of dung, sufficient potash for its healthy growth—differing, like the carrot, markedly in this respect from plants of the cabbage kind. The effect of an insufficient supply of potash is most evident in the case of the plots which are continuously without stable manure. In later years, on these plots, the giving or withholding of potash salts, even when other fertilisers are liberally supplied, has meant the doubling or halving of the crop. The effect of giving or withholding potash salts on the plots that regularly or intermittently received dung is less, but is nevertheless well marked throughout the series.

Whether we have regard to the whole term of years, or to the average of the last twelve seasons—under which two periods the results are grouped it will be seen that on the average a very good crop has been grown from the residue of a double dressing of dung (50 loads or 25 tons per acre) applied to the previous crop. This, however, is only on the average. There have been many seasons in which the crop following the heavy dressing of dung has been well beaten by one or other of the plots on which the parsnips followed a light dressing of dung, supplemented by the direct application of chemical fertilisers.

As far as regards the nitrogenous dressing, if phosphates and potash salts are used for the parsnips (following a light dressing of dung applied for the previous crop), there has been, on the average, no advantage in giving a larger dressing than is represented by 2 cwt. per acre of nitrate of soda. In individual seasons a larger quantity of nitrate has sometimes proved useful, but we think that 2 cwt. per acre will generally ensure a good crop.

Quite good crops have in some seasons been grown on the continuously undunged land by the use of phosphates, potash salts, and nitrate of soda in combination; but on the average these plots have been considerably

lower in yield than the plots to which a light dressing of dung has been applied during the previous year. In fact, the results throughout are very similar to those which we have obtained with carrots.

PARSNIPS.

PLOTS RECEIVING STABLE MANURE (FOR PREVIOUS CROP).

Annual manuring per acre.	Average annual cost of chemical fertilisers per acre.	Average annual weight of parsnips per acre.	
		Sixteen seasons.	Last twelve seasons.
	£ s. d.	tons cwt.	tons cwt.
50 loads (25 tons) London Dung (*applied to previous crop*) . .	—	12 18	13 11
25 loads (12½ tons) London Dung (*applied to previous crop*) . .	—	9 16	9 11
25 loads London Dung (*to previous crop*), Phosphates (no Potash Salts), and 2 cwt. Nitrate of Soda	2 0 0	11 1	10 16
Do., do., with Potash Salts . .	2 10 0	12 18	13 2
25 loads London Dung (*to previous crop*), Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	3 2 0	11 5	11 1
Do., do., with Potash Salts . .	3 12 0	12 12	12 13
25 loads London Dung (*to previous crop*), Phosphates (no Potash Salts), and 6 cwt. Nitrate of Soda	4 4 0	—	12 1
Do., do., with Potash Salts . .	4 14 0	—	13 14

COMPARISON OF PLOTS WITH AND WITHOUT PREVIOUS DRESSINGS OF STABLE MANURE.

Annual manuring per acre.	Average annual cost of chemical fertilisers per acre.	Average annual weight of parsnips per acre.	
		First four seasons.	Last twelve seasons.
	£ s. d.	tons cwt.	tons cwt.
50 loads (25 tons) London Dung (*applied to previous crop*) . .	—	10 18	13 11
25 loads (12½ tons) London Dung (*applied to previous crop*) . .	—	9 3	9 11
No Dung for many years; Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	3 2 0	7 10	—
Do., do., with Potash Salts . .	3 12 0	8 11	—
No Dung for many years; Phosphates (no Potash Salts), and 8 cwt. Nitrate of Soda	5 6 0	—	5 11
Do., do., with Potash Salts . .	5 16 0	—	9 12

RECOMMENDATION as to Manuring of PARSNIPS.

If there happens to be a field which has received the extravagant quantity of 50 loads, or 25 tons, of dung per acre during the preceding year, such land will probably produce a full crop of parsnips without further manuring, always provided that the soil be not of a too open or gravelly character, in which case the residual value of the dung may very well have diminished in such ratio as to be incompatible with the growth of another crop without additional aid. On land that has received a moderate dressing of stable manure for the preceding crop, parsnips can be satisfactorily grown without any further dressing of dung, if they receive a dressing of phosphates (say, 4 to 6 cwt. of superphosphate or 8 cwt. of basic slag per acre), together with 1 cwt. of sulphate of potash (or 4 cwt. of kainit) per acre, and a dressing of nitrate of soda. The phosphates and potash salts should, as in the case of carrots, be well mixed into the soil before sowing. At the time of thinning out, 2 cwt. of nitrate of soda per acre should be sown as a top-dressing between the rows. Following a wet winter, which drains the soil of its natural nitrates, or on soils that are naturally light and open, a further top-dressing of 2 cwt. of nitrate of soda per acre may be advantageously given a month later, but as to the desirability of this the grower will be guided by the growth and vigour of the plants at this stage.

If good results are to be obtained from the phosphates and nitrate of soda, or whatever nitrogenous manure may be used, it is essential that potash salts should be included in the dressing for this crop.

CELERY.

Our soil, as we have observed in earlier reports, is anything but an ideal soil for celery growing. Celery likes a loose, friable, sandy soil—a soil essentially in "garden" condition. For the first five years, however, we grew a crop of celery each year on the same plan as our other vegetables, the only difference being that the chemical fertilisers were sown in the trenches in which the celery was placed instead of being spread broadcast. The dry weather experienced during those early seasons aggravated the natural unkindness of the soil towards a crop like celery, and the plants were mostly small, their average weight being in the best season less than 20 oz. per head on the best plots. The crop was nevertheless every year marketable, and the results, as far as they went, were of interest, indicating that under the conditions of growth

the lighter dressing of dung (25 loads, or 12 to 13 tons per acre), aided by phosphates and a free dressing of nitrate of soda, gave better results than were obtained by the use of 50 loads (25 tons) of dung per acre without chemical fertilisers.

It was evident, however, that in dry weather more stable manure must be used to ensure a good crop. Accordingly we decided to treat this crop more liberally in the way of dung, and for the last thirteen years we have doubled the dressings, the heavily dunged plot having every year received stable manure at the rate of 100 loads (50 tons) per acre, while the "lightly" dunged plots have received 50 loads (25 tons) per acre per annum, with or without artificial help as the case may be.

We have also kept up the growth of the crop on the continuously undunged plots, giving them, however, a larger allowance of nitrate of soda.

The results obtained during the last thirteen seasons are as follows:—

CELERY.

PLOTS RECEIVING STABLE MANURE.

Annual manuring per acre.	Average annual cost of manure per acre.	Average weight per plant. **Thirteen seasons (1899-1911).**
	£ s. d.	ozs.
100 loads (50 tons) London Dung . .	20 0 0	36·5
50 loads (25 tons) London Dung . .	10 0 0	32·2
50 loads London Dung, Phosphates (no Potash Salts), and 2 cwt. Nitrate of Soda	12 0 0	34·2
Do., do., with Potash Salts . . .	12 10 0	34·7
50 loads London Dung, Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	13 2 0	32·8
Do., do., with Potash Salts . . .	13 12 0	32·7
50 loads London Dung, Phosphates (no Potash Salts), and 6 cwt. Nitrate of Soda	14 4 0	32·8
Do., do., with Potash Salts . . .	14 14 0	33·7
No Dung; Phosphates (no Potash Salts), and 8 cwt. Nitrate of Soda	5 6 0	15·1
Do., do., with Potash Salts . . .	5 16 0	25·9

It will be seen that the weight of the plants grown on the plot which has been kept continuously without dung is much below that of the plants grown on the other plots, and we may dismiss this mode of growing as unsatisfactory.

The best plot of all has been the plot to which the inordinately large quantity of 50 tons of stable manure per acre has been annually applied. When half this quantity of stable manure (25 tons per acre) has been given, the average weight per plant is considerably less.

The addition to the lighter dressing of dung of phosphates, potash salts and 2 cwt. of nitrate of soda per acre has produced a distinct improvement in weight, but no advantage has been obtained by increasing the nitrate beyond 2 cwt. per acre when the quantity of dung used has been 25 tons per acre. In the earlier seasons, however, when we used half this quantity of dung, 4 cwt. of nitrate of soda per acre gave better results than 2 cwt.

If the results are viewed from the economical standpoint, it would seem that the increase in weight obtained on the very heavily dunged plot, as compared with that obtained on the more moderately dunged plots, is incommensurate with the very great cost of the extra dung; while, on the other hand, it may be asked whether the increase in weight obtained by the use of the chemical fertilisers on the less heavily dunged plots has in itself been worth the cost and trouble of dressing. Here, however, regard must be had to the question of quality as well as that of weight, and we have, as in the case of many other of our crops, observed that the plants raised by the use of a mixture of dung and chemical fertilisers have been crisper and more tender than those grown with dung alone. The nitrate of soda, although it has produced no great effect upon the weight of the crop, appears to render the growth more rapid and to diminish the strength and toughness of the fibro-vascular bundles in the leaf-stalks, developing rather the growth of soft or parenchymatous tissue.

RECOMMENDATION as to Manuring of CELERY.

As has been already explained, our soil is not what may be regarded as a celery soil, and we are therefore diffident about generalising too largely from the mere results obtained in our experimental field. It appears to be clear, however, that celery, except perhaps on soils particularly well adapted to its cultivation, cannot be grown successfully without the use of much larger quantities of dung or stable manure than are necessary for other crops, and the quantity used, even when reinforced by chemical fertilisers, may well go as far as 50 small loads, or 25 tons, per acre. This should be placed in the trenches, together with a dressing of phosphatic manure—say about 4 to 6 cwt. of superphosphate per acre.

On soils, however, that are poor in lime, it would probably be better to use, in preference to superphosphate, a like quantity of vitriolised bones, or a mixture of 3 cwt. of superphosphate with an equal weight of fine bone meal. The crop during its growth should be top-dressed with 2 cwt. per acre of nitrate of soda. On soils physically favourable to the growth of celery it is possible that this top dressing may advantageously be increased to 4 cwt. of nitrate of soda per acre, although in our own field 2 cwt. has usually been sufficient.

It is to be noted that, even if the concentrated fertilisers do not largely increase the weight of the plants, they will tend to improve the quality of the celery, by making it more crisp and tender than that grown by the use of stable manure alone.

SPINACH (SUMMER).

Summer Spinach is a crop the growth of which is much dependent upon a sufficient rainfall at a critical time, and on this account our crop has in several years failed, while other years it has been small. On the other hand, in favourable seasons, we have grown excellent crops. The average results which we have obtained over ten seasons are shown in the tables on p. 77.

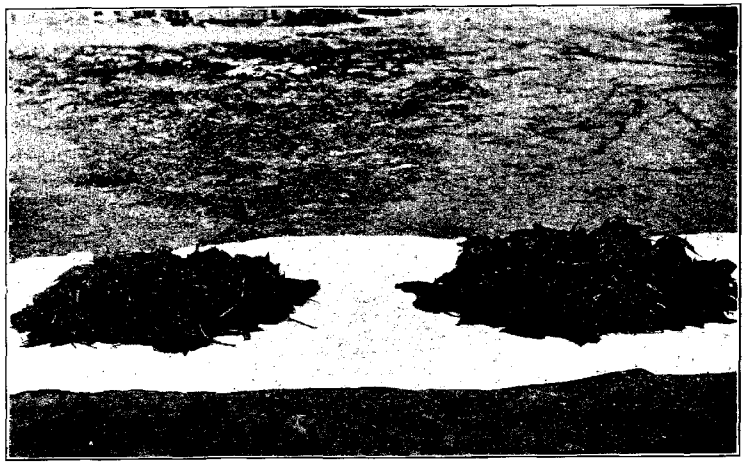
It should be mentioned that, both as regards summer and winter spinach, we have not gathered the crops leaf by leaf as they would be gathered in ordinary market gardening, but have each year allowed the crop to stand undisturbed until it has just reached the flowering stage, when we cut and weighed the entire crop of green stuff. Although the weights per acre thus obtained are probably not the same as those that would be obtained by plucking the leaves singly during the life of the plant, they are probably equally good for purposes of comparison.

Regarding first the upper table, we see that, although the heavy dressing of dung has very much bettered the yield of the light dressing, it has been insufficient to produce a full crop. Much the best crops have been grown by using, in addition to a light dressing of dung, a dressing of phosphates, with a liberal application of nitrate of soda.

The results given in the lower table show that, by the free use of chemical fertilisers without dung, we have been able to grow a heavier crop than by the use of dung alone; but we would not recommend this mode of growing, except, perhaps, on ground that has been recently dunged for other crops, in which case it should give satisfactory results.

Except on the continuously undunged plots, potash salts have on the

SPINACH.



Crop, 2 tons 12½ cwt. per acre.
Manure per acre—
50 loads (25 tons) London Dung
(cost about £10 per acre).

Crop, 4 tons 12¾ cwt. per acre.
Manure per acre—
4 cwt. Nitrate of Soda,
4 cwt. Superphosphate,
1 cwt. Sulphate of Potash,
25 loads (12½ tons) London Dung
(cost about £8 per acre).

SUMMER SPINACH.

PLOTS RECEIVING STABLE MANURE

Annual manuring per acre.	Average annual cost of manure per acre.	Average annual yield of spinach per acre.	
		Ten seasons.	**Last six seasons.**
	£ s. d.	tons cwt.	tons cwt.
50 loads (25 tons) London Dung .	10 0 0	6 1	7 10
25 loads (12½ tons) London Dung .	5 0 0	4 16	5 10
25 loads London Dung, Phosphates (no Potash Salts), and 2 cwt. Nitrate of Soda	7 0 0	6 14	8 5
Do., do., with Potash Salts . .	7 10 0	7 3	8 13
25 loads London Dung, Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	8 2 0	7 15	9 10
Do., do., with Potash Salts . .	8 12 0	7 16	9 14
25 loads London Dung, Phosphates (no Potash Salts), and 6 cwt. Nitrate of Soda	9 4 0	—	10 6
Do., do., with Potash Salts . .	9 14 0	—	10 7

COMPARISON OF PLOTS WITH AND WITHOUT STABLE MANURE.

Annual manuring per acre.	Average annual cost of manure per acre.	Average annual yield of spinach per acre.	
		First four seasons.	**Last six seasons.**
	£ s. d.	tons cwt.	tons cwt.
50 loads (25 tons) London Dung .	10 0 0	4 0	7 10
25 loads (12½ tons) London Dung	5 0 0	3 15	5 10
25 loads London Dung, Phosphates, and 4 cwt. Nitrate of Soda	8 2 0	5 2	9 10
25 loads London Dung, Phosphates, and 6 cwt. Nitrate of Soda	9 4 0	—	10 6
No Dung; Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	3 2 0	3 2	—
Do., do., with Potash Salts . .	3 12 0	3 11	—
No Dung; Phosphates (no Potash Salts), and 8 cwt. Nitrate of Soda	5 6 0	—	5 15
Do., do., with Potash Salts . .	5 16 0	—	8 5

average produced little effect on our yield of Summer Spinach, although there have been seasons which have afforded exceptions in the case of individual plots.

RECOMMENDATION as to Manuring of SUMMER SPINACH.

We recommend a light dressing of dung (25 loads, or 12 to 13 tons, per acre), with from 4 to 6 cwt. of superphosphate per acre, well incorporated with the soil before sowing. Nitrate of soda should then be given in successive top dressings of 2 cwt. per acre, the total quantity of nitrate being from 4 to 6 cwt. per acre, according to the season and the growth of the crop.

On land that has been well dunged for a preceding crop, Summer Spinach can be grown without any further application of dung, but 1 cwt. of sulphate of potash (or 4 cwt. of kainit) per acre should in that case be worked into the ground with the superphosphate some little time before sowing. In districts where the average rainfall is small, however, it is safer to combine the use of dung with that of chemical fertilisers.

WINTER SPINACH.

In our earlier seasons we grew Winter Spinach as a "catch crop" after summer spinach, without further manuring, and showed that it was possible to grow a good crop in this way. Latterly, however, we have grown winter spinach as a main crop, applying manure to it direct, with the result that our crops have been very much larger. The average results of six crops grown in this way, in 1905, 1907, 1908, 1909, 1910, and 1911, are shown in the table on p. 79.

It will be seen that heavy dunging has given a much better result than light dunging, but the results even of the heavy dunging have been poor compared with those obtained by the use of a light dressing of dung supplemented by chemical fertilisers. This crop is evidently very responsive to nitrogenous manure, the most successful plot being that receiving 6 cwt. of nitrate of soda per acre, which has yielded 5 tons more per acre than either of the plots receiving smaller dressings of nitrate.

Chemical fertilisers without any dung at all have produced better results than heavy dunging without their aid, but the yield has been far behind that obtained when dung and a liberal dressing of chemical fertilisers were used together.

WINTER SPINACH.

Annual manuring per acre.	Average annual cost of manure per acre.	Average annual yield of winter spinach per acre. **Six seasons.**
	£ s. d.	tons cwt.
50 loads (25 tons) London Dung . .	10 0 0	27 11
25 loads (12½ tons) London Dung . .	5 0 0	20 19
25 loads London Dung, Phosphates (no Potash Salts), and 2 cwt. Nitrate of Soda	7 0 0	28 6
Do., do., with Potash Salts . . .	7 10 0	28 5
25 loads London Dung, Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	8 2 0	30 18
Do., do., with Potash Salts . . .	8 12 0	30 13
25 loads London Dung, Phosphates (no Potash Salts), and 6 cwt. Nitrate of Soda	9 4 0	34 6
Do., do., with Potash Salts . . .	9 14 0	34 10
No Dung; Phosphates (no Potash Salts), and 8 cwt. Nitrate of Soda	5 6 0	25 4
Do., do., with Potash Salts . . .	5 16 0	28 11

Potash salts have produced a marked effect on the plots which are continuously kept without dung, but in the presence of dung their use has not increased the crop. This agrees with our experience in regard to summer spinach.

RECOMMENDATION as to Manuring of WINTER SPINACH.

It is best to dung the ground for winter spinach at the rate of about 25 loads (12 to 13 tons) of stable manure per acre, giving at the same time—either before the crop is sown or during the preparation of the seed bed—a dressing of 4 to 6 cwt. per acre of superphosphate, or, on soils poor in lime, 6 to 8 cwt. of basic slag or its equivalent in other phosphatic manures. In the early spring the crop should be top-dressed with 6 cwt. of nitrate of soda per acre, given in successive dressings of 2 cwt. per acre at intervals of about a fortnight. If it is not convenient to apply a special dressing of dung, the crop may be grown with chemical fertilisers only, following a crop that has been dunged. In this case 1 cwt. of sulphate of potash or 4 cwt. of kainit per acre may be applied at the same time as the phosphatic manure, especially on light soils.

BEETROOTS.

We have grown sixteen crops of Beetroots, the results from which are embodied in the following tables:—

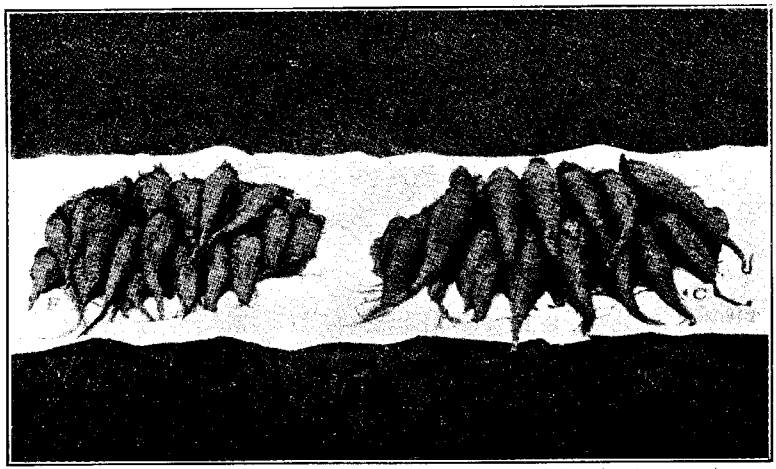
PLOTS RECEIVING STABLE MANURE

Annual manuring per acre.	Average annual cost of manure per acre.	Average annual yield of beetroots per acre.	
		Sixteen seasons.	Last thirteen seasons.
	£ s. d.	tons cwt.	tons cwt.
50 loads (25 tons) London Dung .	10 0 0	12 19	12 6
25 loads (12½ tons) London Dung .	5 0 0	11 3	10 12
25 loads London Dung, Phosphates (no Potash Salts), and 2 cwt. Nitrate of Soda	7 0 0	11 9	10 15
Do., do., with Potash Salts . .	7 10 0	12 1	11 12
25 loads London Dung, Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	8 2 0	12 2	11 2
Do., do., with Potash Salts . .	8 12 0	11 10	10 11
25 loads London Dung, Phosphates (no Potash Salts), and 6 cwt. Nitrate of Soda	9 4 0	—	12 9
Do., do., with Potash Salts . .	9 14 0	—	11 6

COMPARISON OF PLOTS WITH AND WITHOUT STABLE MANURE.

Annual manuring per acre.	Average annual cost of manure per acre.	Average annual yield of beetroots per acre.	
		First three seasons.	Last thirteen seasons.
	£ s. d.	tons cwt.	tons cwt.
50 loads (25 tons) London Dung .	10 0 0	15 11	12 6
25 loads (12½ tons) London Dung .	5 0 0	13 11	10 12
25 loads London Dung, Phosphates (no Potash Salts), and 2 cwt. Nitrate of Soda	7 0 0	14 11	10 15
Do., do., and 4 cwt. Nitrate of Soda	8 2 0	16 5	11 2
Do., do., and 6 cwt. Nitrate of Soda	9 4 0	. .	12 9
No Dung; Phosphates (no Potash Salts) and 4 cwt. Nitrate of Soda	3 2 0	11 5	—
Do., do., with Potash Salts . .	3 12 0	13 16	
No Dung; Phosphates (no Potash Salts) and 8 cwt. Nitrate of Soda	5 6 0	—	6 18
Do., do., with Potash Salts . .	5 16 0	—	10 17

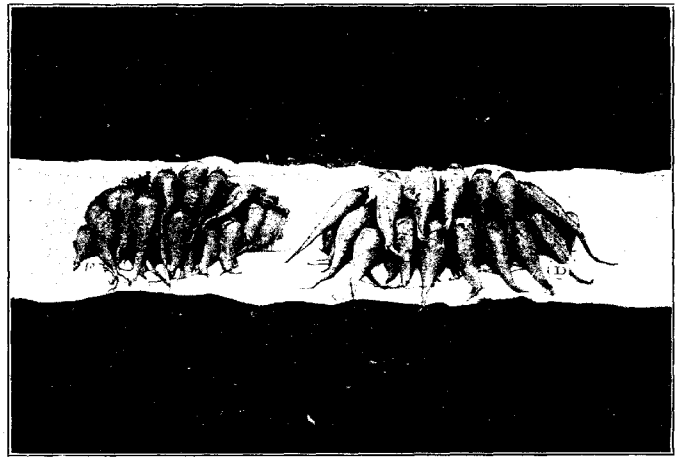
BEETROOTS.



Crop, 10 tons 8 cwt. per acre.
Manure per acre—
25 tons London Dung
(cost £10 per acre).

Crop, 12 tons 1 cwt. per acre.
Manure per acre—
No Dung,
10 cwt. Basic Slag,
1 cwt. Sulphate of Potash,
8 cwt. Nitrate of Soda
(cost £6 5*s.* per acre).

BEETROOTS.



Crop, 10 tons 8 cwt. per acre.

Manure per acre—
25 tons London Dung

(cost £10 per acre).

Crop, 12 tons 14 cwt. per acre.

Manure per acre—
12½ tons London Dung,
10 cwt. Basic Slag,
1 cwt. Sulphate of Potash,
4 cwt. Nitrate of Soda

(cost £8 15*s.* per acre).

The heaviest crop has been most frequently produced by the heavy dressing of dung, and, but for its cost, we should regard this mode of growing as preferable for beetroots on our soil. Substantially the same results, however, were obtained, on an average of sixteen seasons, by the use of the lighter dressing of dung supplemented by a dressing of phosphatic manure and from 2 to 4 cwt. of nitrate of soda per acre. During the last thirteen years we have obtained better results by increasing the nitrate to 6 cwt. per acre, but on the whole we should not recommend so heavy a dressing.

On reference to the lower table it will be seen that very fair crops of beetroots can be grown without the use of dung, but in this case it is very essential that a dressing of potash salts should be included in the fertilisers used, although no special application of potash salts appears to be necessary, on our land, in the case of the plots to which a moderate quantity of dung is regularly applied. Our beetroot crop grown on continuously undunged land without potash salts has often been scarcely worth gathering, despite the liberal application of phosphates and nitrate of soda.

Although, however, by the use of a complete chemical dressing without dung we are usually able to grow fair crops of beetroots, we do not recommend this plan, for there is much more chance of getting a good regular plant in the presence of dung than in its absence, especially if the spring happens to be a dry one.

RECOMMENDATION as to Manuring of BEETROOTS.

Beetroots should get a light dressing (about 25 loads or 12 to 13 tons per acre) of stable manure, with from 4 to 6 cwt. per acre of superphosphate, or an equivalent quantity of basic slag, etc. On light soils 1 cwt. of sulphate of potash or 4 cwt. of kainit per acre may be added, but on most heavy land this will probably be superfluous in the presence of dung. A top dressing of 2 cwt. of nitrate of soda per acre should be given shortly after the plant is up, and a further dressing of 2 cwt. per acre may be given at discretion, according to the appearance of the plant, about a fortnight after singling out. In some seasons a good crop may be expected on land dunged for the previous crop, without any further application of stable manure, by the use of a dressing of 6 cwt. of superphosphate per acre (or its equivalent), 1 cwt. of sulphate of potash (or 4 cwt. of kainit), and from 4 to 6 cwt. of nitrate of soda per acre. The phosphatic manure and potash salts should be well mixed with the soil during the preparation of the seed

bed, or earlier, and the nitrate of soda given in two top dressings. On light soils, however, the application of a moderate quantity of dung is desirable.

RHUBARB.

We have from time to time made several plantations of Rhubarb, of both large or coarse and smaller or fine varieties. The large variety which we have grown is the well-known "Victoria" Rhubarb. Of small varieties we at first grew three, namely, "Royal Albert," "Paragon," and "Johnson's St. Martin"; but we had a good deal of trouble through plants of the latter varieties dying off in the winter and needing to be replaced, and latterly we have grown "Royal Albert," as having proved the most hardy on our soil.

LARGE VARIETY ("VICTORIA").

The average results which we have obtained over eleven seasons with the large or coarse variety are shown in the tables on p. 87.

It will be seen that 25 loads per acre of town dung has proved to be an insufficient dressing, while the doubling of this quantity of dung has produced a large increase, both in the number of sticks pulled and in the gross weight. It will be seen, however, that on the average of eleven seasons quite as good a result has been obtained from the smaller dressing of dung supplemented by dressings of phosphates, potash salts and 4 cwt. of nitrate of soda per acre. During the last seven seasons the crops on the average have been greater, owing to more favourable weather; but here also a light dressing of dung, accompanied by a chemical dressing including 4 cwt. of nitrate of soda per acre, has done nearly as well as the heavy dressing of dung, while this latter plot has been well beaten when the dressing of nitrate has been increased to 6 cwt. per acre.

The general effect of the dressings can perhaps be better gathered from the following short table:—

RHUBARB—LARGE VARIETY ("VICTORIA").

Manure annually applied in addition to 25 loads London Dung per acre.	Average annual cost of extra manure per acre.	Average annual INCREASE in yield of rhubarb per acre, over and above that obtained by the use of 25 loads London Dung per acre. **Last seven seasons.**	
	£ s. d.	Sticks.	tons cwt.
25 extra loads Dung (50 in all) .	5 0 0	36,010	18 13
Phosphates, Potash Salts, and 4 cwt. Nitrate of Soda	3 12 0	34,170	16 17
Phosphates, Potash Salts, and 6 cwt. Nitrate of Soda	4 14 0	43,730	20 9

VICTORIA RHUBARB.



Crop, 49 tons 11 cwt. per acre.

Manured with 4 cwt. Superphosphate and 4 cwt. Nitrate of Soda per acre, costing £2 10s. per acre. No Dung used.

RHUBARB—LARGE OR COARSE VARIETY ("VICTORIA").

PLOTS RECEIVING STABLE MANURE.

Annual manuring per acre.	Average annual cost of manure per acre.	Eleven seasons. Average annual number of sticks or stalks pulled per acre.	Eleven seasons. Average annual weight of crop per acre.	Last seven seasons. Average annual number of sticks or stalks pulled per acre.	Last seven seasons. Average annual weight of crop per acre.
	£ s. d.		tons cwt.		tons cwt.
50 loads (25 tons) London Dung	10 0 0	116,200	50 13	141,980	57 8
25 loads (12½ tons) London Dung	5 0 0	93,040	34 9	105,970	38 15
25 loads London Dung, Phosphates (no Potash Salts), and 2 cwt. Nitrate of Soda	7 0 0	100,400	41 4	107,750	44 2
Do., do., with Potash Salts	7 10 0	96,650	36 11	94,980	35 18
25 loads London Dung, Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	8 2 0	112,050	43 6	101,860	42 5
Do., do., with Potash Salts	8 12 0	124,100	50 4	140,140	55 12
25 loads London Dung, Phosphates (no Potash Salts), and 6 cwt. Nitrate of Soda	9 4 0	—	—	139,080	55 12
Do., do., with Potash Salts	9 14 0	—	—	149,700	59 4

COMPARISON OF PLOTS WITH AND WITHOUT STABLE MANURE.

Annual manuring per acre.	Average annual cost of manure per acre.	First four seasons. Average annual number of sticks or stalks pulled per acre.	First four seasons. Average annual weight of crop per acre.	Last seven seasons. Average annual number of sticks or stalks pulled per acre.	Last seven seasons. Average annual weight of crop per acre.
	£ s. d.		tons cwt.		tons cwt.
50 loads (25 tons) London Dung	10 0 0	97,310	38 15	141,980	57 8
25 loads (12½ tons) London Dung	5 0 0	70,440	27 0	105,970	38 15
25 loads London Dung, Phosphates, Potash Salts, and 4 cwt. Nitrate of Soda	8 12 0	96,050	40 16	140,140	55 12
25 loads London Dung, Phosphates, Potash Salts, and 6 cwt. Nitrate of Soda	9 14 0	—	—	149,700	59 4
No Dung; Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	3 2 0	92,860	37 16	—	—
Do., do., with Potash Salts	3 12 0	94,640	37 0	—	—
No Dung; Phosphates (no Potash Salts), and 8 cwt. Nitrate of Soda	5 6 0	—	—	129,700	49 16
Do., do., with Potash Salts	5 16 0	—	—	130,020	51 1

Turning to the lower table on page 87, it will be seen that, even in the absence of dung, the application of chemical fertilisers, including liberal dressings of nitrate of soda, has also enabled us to raise heavy crops in the case of large rhubarb, at a much smaller expense than by the use of dung.

During the earlier seasons potash salts appeared to be of little use for large or coarse rhubarb, but in recent more prolific seasons a substantial advantage appears to have been derived from the inclusion of potash salts in the dressing of chemical fertilisers, even in the presence of dung.

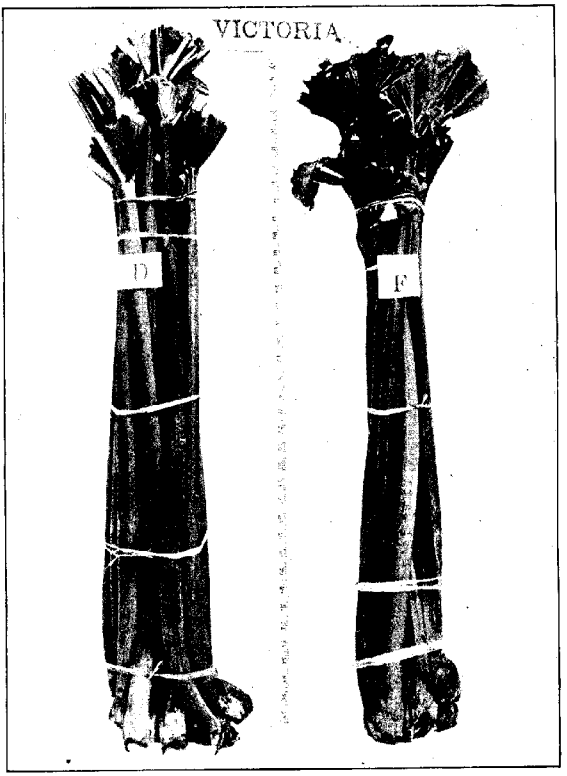
SMALL RHUBARB.

The tables on page 91 show our average results for the small or fine varieties of rhubarb.

Here, again, there is a very great advantage in favour of heavy as compared with light dunging, and on the whole heavy dunging has proved with us to be the best treatment for light or delicate varieties. The results obtained on the various plots have been, for reasons already referred to, much less regular than in the case of the large rhubarb, and do not point to such clear conclusions. It will be evident from them, however, that good crops of small rhubarb can be grown with a light dressing of dung, supplemented by chemical fertilisers; but it will also be seen that, differently from the case of large rhubarb, satisfactory results do not seem to be obtainable in the absence of dung, however liberal the chemical dressings may be. The recommendations which we are about to make for small rhubarb are based rather upon notes and observations in individual seasons than upon the average figures shown in the tables of results.

We have here again to point out that economy of production obtained by the proper use of chemical fertilisers is only one of the features brought out by our experiments. The quality of the rhubarb in the case of the heavy crops grown rapidly with the aid of chemical fertilisers, including a liberal quantity of nitrate of soda, is far better than in the case of the produce grown with dung alone. This superiority in quality consists mainly, as in the case of other vegetables, in a greater degree of tenderness due to a larger development of soft cellular tissue and a corresponding decrease in the proportion of tough vascular fibre—or at any rate in the toughness of the latter. The chemically dressed rhubarb, when examined raw, will be found to be more crisp and tender, and repeated trials show that it take less time to cook, and when cooked is more

SPECIMEN GROWTH OF VICTORIA RHUBARB.



(The scale shows inches).

Crop per acre—
40 tons 3 cwt.

Manure per acre—
12½ tons London Dung,
4 cwt. Nitrate of Soda,
4 cwt. Superphosphate

(cost £7 12s. per acre).

Crop per acre—
30 tons 7½ cwt.

Manure per acre—
25 tons London Dung without chemical fertilisers

(cost £10 per acre).

RHUBARB—SMALL OR FINE VARIETY (CHIEFLY "ROYAL ALBERT").

PLOTS RECEIVING STABLE MANURE.

Annual manuring per acre.	Average annual cost of manure per acre.	Seven seasons. Average annual number of stalks or sticks pulled per acre.	Seven seasons. Average annual weight of crop per acre.	Last three seasons. Average annual number of stalks or sticks pulled per acre.	Last three seasons. Average annual weight of crop per acre.
	£ s. d.		tons cwt.		tons cwt.
50 loads (25 tons) London Dung	10 0 0	139,800	22 19	185,000	27 12
25 loads (12½ tons) London Dung	5 0 0	95,300	14 19	139,900	18 8
25 loads London Dung, Phosphates (no Potash Salts), and 2 cwt. Nitrate of Soda	7 0 0	108,100	17 8	119,800	18 0
Do., do., with Potash Salts	7 10 0	97,200	17 14	91,700	15 15
25 loads London Dung, Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	8 2 0	108,600	20 0	128,800	18 10
Do., do., with Potash Salts	8 12 0	123,200	21 10	162,200	24 7
25 loads London Dung, Phosphates (no Potash Salts), and 6 cwt. Nitrate of Soda	9 4 0	—	—	166,300	23 18
Do., do., with Potash Salts	9 14 0	—	—	158,400	27 18

COMPARISON OF PLOTS WITH AND WITHOUT STABLE MANURE.

Annual manuring per acre.	Average annual cost of manure per acre.	First four seasons. Average annual number of stalks or sticks pulled per acre.	First four seasons. Average annual weight of crop per acre.	Last three seasons. Average annual number of stalks or sticks pulled per acre.	Last three seasons. Average annual weight of crop per acre.
	£ s. d.		tons cwt.		tons cwt.
50 loads (25 tons) London Dung	10 0 0	105,875	19 9	185,000	27 12
25 loads (12½ tons) London Dung	5 0 0	61,900	12 8	139,900	18 8
25 loads London Dung, Phosphates, Potash Salts, and 4 cwt. Nitrate of Soda	8 12 0	93,950	19 9	162,200	24 7
25 loads London Dung, Phosphates, Potash Salts, and 6 cwt. Nitrate of Soda	9 14 0	—	—	158,400	27 18
No Dung; Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	3 2 0	66,575	13 2	—	—
Do., do., with Potash Salts	3 12 0	79,800	12 17	—	—
No Dung; Phosphates (no Potash Salts), and 8 cwt. Nitrate of Soda	5 6 0	—	—	123,700	18 18
Do., do., with Potash Salts	5 16 0	—	—	132,800	17 3

pleasant to eat, than the rhubarb grown more slowly by the use of dung alone.

RECOMMENDATION as to Manuring of RHUBARB.

For small varieties a heavy dressing of stable manure (50 loads or 25 tons per acre) will give excellent results as regards quantity of crop, but is expensive. Half this quantity (that is to say, 25 loads or 12 to 13 tons per acre), with 4 to 6 cwt. of superphosphate or its equivalent in basic slag, etc., 1 cwt. of sulphate of potash, and 4 cwt. of nitrate of soda per acre, may be relied upon to produce a good crop.

In the case of large or coarse rhubarb we should not recommend heavy dunging. A light dressing of dung (25 loads or 12 to 13 tons per acre) should be given annually, with 6 cwt. of superphosphate or 8 cwt. of basic slag (on soils poor in lime these may be given in alternate years), 1 cwt. of sulphate of potash or 4 cwt. of kainit, and 6 cwt. of nitrate of soda per acre. The nitrate may be divided into two dressings, the first being put on when the plants appear above ground and the second a fortnight later.

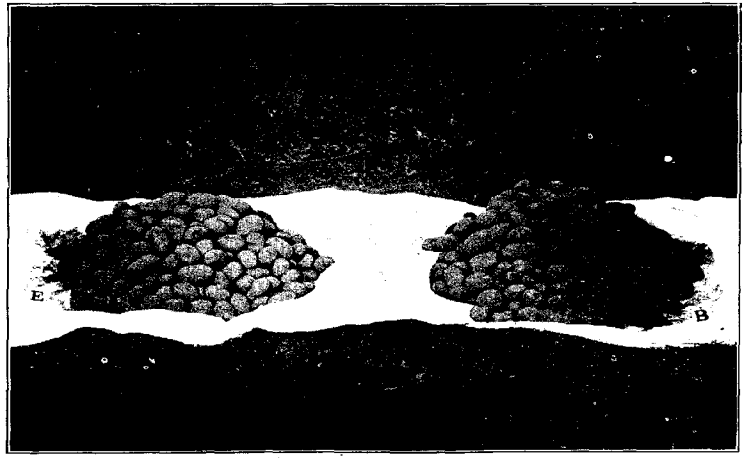
It should be observed that our experiments and recommendations as to rhubarb all relate to rhubarb grown for bulk, with a view to the sale of the leaf-stalks in a state of mature development. We have not grown "forced" or early rhubarb.

POTATOES.

THE potato-producing capacity of a soil probably depends more upon its mechanical condition than upon anything else, and the weight of the crop is more profoundly affected by variations in rainfall or sunshine than in the case of almost any other crop with which the market grower has to do. In some seasons a very moderate manuring suffices for a heavy crop, while in other seasons even heavy manuring will not produce more than a moderate yield; and very diverse conclusions may be drawn from practical trials on potato manuring, according to the season in which they happen to have been made. It is only from continuous experience in any given locality that sound conclusions can be drawn for general guidance.

We have grown nearly every year two crops of Potatoes, one early and one late. The early varieties were, from 1895 to 1898 "Windsor Castle," from 1899 to 1901 "Webber's White Beauty," from 1902 to 1905 "Early Rose," in 1906 and 1907 "Sir John Llewellyn," in 1908 "Ninetyfold," and in 1909, 1910 and 1911 "Early Rose." For our late or main crop we grew in 1894 "Beauty of Hebron," in 1895 "Magnum

POTATOES ("Up-to-date").



Crop, 7 tons 7 cwt. per acre.
Manure per acre—
12½ tons London Dung
(cost £5 per acre).

Crop, 9 tons 9 cwt. per acre.
Manure per acre—
12½ tons London Dung,
10 cwt. Basic Slag,
1 cwt. Sulphate of Potash,
2 cwt. Nitrate of Soda
(cost £7 15*s*. per acre).

Bonum," in 1896 "Imperator," in 1897 and 1898 "Magnum Bonum," from 1899 to 1901 "Up-to-date," in 1902 "British Queen," from 1903 to 1905 "Up-to-date," in 1906 "Duchess of Cornwall," and from 1907 to 1911 "Up-to-date." Our average results are shown in the following table:—

POTATOES.

Annual manuring per acre.	Average annual cost of manure per acre.	Average annual yield of potatoes per acre.	
		EARLY varieties. **Seventeen seasons (1895-1911).**	LATE varieties. **Eighteen seasons (1894-1911).**
	£ s. d.	tons cwt.	tons cwt.
50 loads (25 tons) London Dung .	10 0 0	7 9	11 3
25 loads (12½ tons) London Dung	5 0 0	5 19	9 3
25 loads London Dung, Phosphates (no Potash Salts), and 2 cwt. Nitrate of Soda	7 0 0	6 10	9 17
Do., do., with Potash Salts . .	7 10 0	6 15	10 15
25 loads London Dung, Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	8 2 0	6 13	10 3
Do., do., with Potash Salts . .	8 12 0	6 16	11 9
No Dung; Phosphates (no Potash Salts) and Nitrate of Soda (4 cwt. till 1899, 8 cwt. since)	4 9 0	3 7	5 11
Do., do., with Potash Salts . .	4 19 0	4 16	7 8

During the last twelve years a plot has also been included on which the chemical dressings given in addition to a light application of dung included as much as 6 cwt. of nitrate of soda per acre; but on the whole no advantage has been obtained by the use of this increased quantity of nitrate.

As far as the early varieties are concerned, the best results have been obtained by the use of a heavy dressing of stable manure. Not only does this appear as an average conclusion, but it holds good individually for twelve of the seventeen seasons. Good results, however, have been obtained with half the quantity of dung supplemented by phosphates, potash salts, and 2 cwt. of nitrate of soda per acre. Nevertheless, in some dry seasons the advantage, in the case of early potatoes, has, from an economical point of view, lain with the heavier application of stable manure, and as the value of early potatoes is much influenced by their earliness, this seems to be a case in which the extravagance of heavy

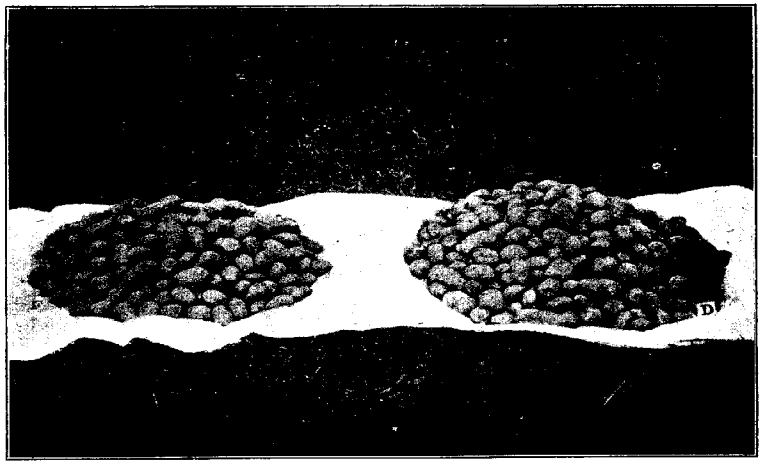
dunging is on the whole probably justified, at all events on such stiff or heavy soil as we have at Hadlow. On lighter soils probably the smaller dressing of dung, helped by chemical fertilisers, would suffice.

When, however, we come to the consideration of the late or main crop, no advantage seems to lie with such heavy applications of stable manure, for the average crop produced by 50 loads of dung per acre over eighteen years is not much greater than the average crop produced with half this quantity of dung supplemented by phosphates, potash salts, and 2 cwt. of nitrate of soda per acre, and is less than the crop grown under similar conditions, but with 4 cwt. of nitrate per acre instead of 2 cwt. In every year but two the heavily dunged plot has been behind the best of the other plots.

The use of potash salts has on the average increased our potato crop throughout, but the effect of potash on the early varieties has been much less than on the late or main crop. Indeed, in the case of the early varieties, when a light dressing of dung has been given, potash salts on the average have not done more than repay their cost, though in some individual heavily cropping seasons the effect has been more appreciable. In the case of the late or main crop varieties, however, potash salts have regularly produced a good effect, and appear to be indispensable for obtaining a full yield. Seeing that potatoes are essentially a potash-loving crop, it is curious that the early potatoes, which have to grow more rapidly, and might therefore be expected to be more exacting in their demands, should seem to have a greater facility for utilising the potash of the dung and of the soil than the later and more leisurely growing crop; but such has been the fact on our soil.

The well-known need of potatoes for potash is, however, strikingly brought out in the case of the early as well as of the late varieties on those plots to which no dung at all has been applied. Although we have each year included such plots (that is to say, chemically manured plots receiving no dung) this method of growing potatoes may be regarded as a comparative failure on our stiff soil whenever the season is at all dry. In one year, it is true, we grew 9½ tons per acre of "Windsor Castle" potatoes, and in another year nearly 12 tons of "Early Rose," by the use of chemical fertilisers only, on land kept continuously deprived of dung; but such experience is exceptional. With the late varieties the yield obtained by the use of chemical fertilisers only, without the aid of dung, has been much better than in the case of the early varieties, and in some

POTATOES ("Up-to-date").



Crop, 9 tons per acre.

Manure per acre—
25 tons London Dung

(cost £10 per acre).

Crop, 12 tons per acre.

Manure per acre—
12½ tons London Dung,
10 cwt. Basic Slag,
1 cwt. Sulphate of Potash,
4 cwt. Nitrate of Soda

(cost £8 15*s.* per acre).

years this mode of growing has been remunerative; but on the whole it is not to be commended on stiff soil.

RECOMMENDATION as to Manuring of POTATOES.

For *early* potatoes the most satisfactory manuring, on our heavy soil, appears to be a heavy application of stable manure (50 loads, or 25 tons per acre). Probably this might advantageously be supplemented by a light dressing of chemical fertilisers. Good crops, however, can be less expensively grown by the use of half the quantity of dung (that is to say, 25 loads, or 12 to 13 tons per acre), with 4 cwt. of superphosphate, and 1 cwt. of sulphate of potash (applied before planting), and 2 cwt. of nitrate of soda per acre given as top dressing.

For *late* varieties, on such soil as ours, 25 loads (12 to 13 tons) of stable manure, with 4 to 6 cwt. of superphosphate, 1 cwt. of sulphate of potash, and 4 cwt. of nitrate of soda per acre, may be relied upon to produce a good crop. The dung, superphosphate, and sulphate of potash should be well mixed into the soil before planting, and in this case half the nitrate may be top-dressed along the rows immediately after planting, the remaining 2 cwt. per acre being given after earthing up.

The nature of the soil, however, is an important factor in the manuring as well as in the general management of the potato crop, and must be taken into account in individual cases.

SPRING OR SUMMER ONIONS.

Our soil is anything but a typical onion soil. Onions, as a rule, like a soil having a free and open tilth—not clay. With Tripoli or Winter onions we are usually successful, but as regards Spring or Summer onions our crops are small in dry summers, and in some seasons a dry seed time has prevented our getting a plant. We have, however, succeeded in growing fifteen crops, and in one year grew, on most of our plots, over 12 tons per acre. The first three crops, however, were grown in such dry seasons, and were in consequence so irregular, that it would be scarcely fair to include them in our record of averages, which we are therefore confining to the crops grown in the last twelve consecutive seasons, which, notwithstanding the natural "unkindness" of the soil, have averaged

between 7 and 8 tons per acre. The results are shown in the table given below.

Perhaps the most striking point in these figures is the small average increase obtained by doubling the lighter dressing of dung. There have been seasons in which the effect of this has been greater than is indicated by the average; but, on the other hand, there have been years in which the doubling of the dung has done no good at all. Nearly as large an increase has been obtained by supplementing the smaller dressing of dung with a moderate dressing of chemical fertilisers, including as little as 2 cwt. of nitrate of soda per acre. In some individual seasons 4 cwt. of nitrate has been more remunerative than 2 cwt., but not on the average.

SPRING OR SUMMER ONIONS.

Annual manuring per acre.	Average annual cost of manure per acre.	Average annual weight of onions per acre. **Twelve seasons (1900-1911).**
	£ s. d.	tons cwt.
50 loads (25 tons) London Dung . .	10 0 0	7 13
25 loads (12½ tons) London Dung . .	5 0 0	6 16
25 loads London Dung, Phosphates (no Potash Salts), and 2 cwt. Nitrate of Soda	7 0 0	6 18
Do., do., with Potash Salts	7 10 0	7 8
25 loads London Dung, Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	8 2 0	7 7
Do., do., with Potash Salts	8 12 0	7 7
25 loads London Dung, Phosphates (no Potash Salts), and 6 cwt. Nitrate of Soda	9 4 0	7 8
Do., do., with Potash Salts	9 14 0	7 8
No Dung; Phosphates (no Potash Salts) and 8 cwt. Nitrate of Soda	5 6 0	1 15
Do., do., with Potash Salts	5 16 0	5 8

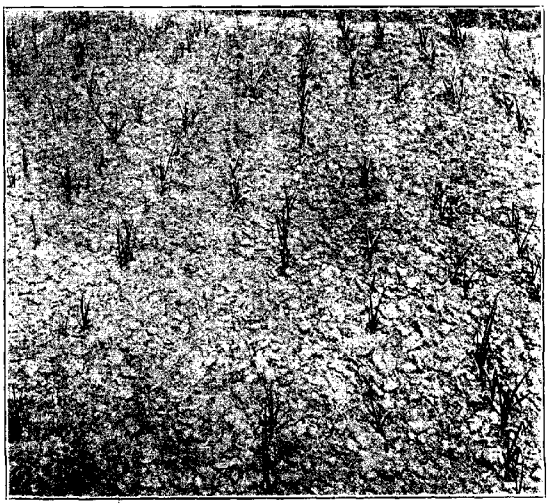
In the presence of a moderate quantity of dung, potash salts, on the whole, have not proved to be necessary. That potash is a very essential element of food for onions is, however, strikingly indicated by a comparison of the results obtained on the two chemically manured plots which have been continuously kept without dung. Here the crop is nearly trebled in weight by the addition of potash salts: in fact, in some years it has been difficult to get a plant at all on the non-potash plot, and we

SUMMER ONIONS, 1902.

(Illustrating complete failure of crop owing to non-supply of Potash in the absence of Dung.)



Manured with Superphosphate, Nitrate of Soda, and *Sulphate of Potash.*



Similarly manured, but *without Potash*

have had years of total failure on this plot. This is well illustrated in the accompanying photograph taken in the summer of 1902.

RECOMMENDATION as to Manuring of SPRING OR SUMMER ONIONS.

Feeling that our soil is not one really suitable for this crop, we hesitate to interpret the indications of our results too confidently. A detailed study of the weights yielded on the different plots in individual years seems to indicate that the produce per acre has been limited rather by conditions of weather than by the direct supply of nutriment to the crop, and there are indications that under more suitable conditions larger dressings might be used than those which have proved the most economical with us. We are disposed, as a general recommendation, to suggest a moderate dressing of dung (25 loads, or 12 to 13 tons per acre) accompanied by 4 to 6 cwt. per acre of superphosphate—or its equivalent in other phosphatic manures—1 cwt. of sulphate of potash (or 4 cwt. of kainit) and 2 cwt. to 4 cwt. of nitrate of soda per acre, the quantity of the latter being determined by the season and appearance of growth. The nitrate should be applied as top-dressing, and if 4 cwt. are given it should be divided into two dressings with an interval of a few weeks between them, the first dressing being given after the crop is thinned out. On soils that have been persistently dressed with stable manure, the potash dressing will, no doubt, in many cases be superfluous; but on light soils, or on soils that have not previously been liberally dunged, it would appear to be wise to include potash salts in the general dressing, in view of the serious effect on this crop which follows an insufficiency of potash, as demonstrated on our undunged plots.

TRIPOLI (WINTER) ONIONS.

We have grown Tripoli Onions successfully in every season except two in which we have attempted them, and only in one season has the crop, owing to unfavourable weather, been really meagre. Over fourteen seasons the yield of our good plots has averaged 14 to 15 tons per acre.

It will be seen from the table on p. 104 that there has been a large return from the use of a heavy quantity of dung, but that this return has been gained at too great an expense. Heavier crops have been grown for less money by using, in addition to the smaller quantity of dung, a free dressing of chemical fertilisers. The best results have been obtained by the use of a light dressing of dung, phosphatic manure, potash salts, and

4 cwt. of nitrate of soda per acre. In some years 2 cwt. per acre of nitrate of soda has proved sufficient, but on the whole 4 cwt. has done better, and in some individual seasons the extra 2 cwt. has been very remunerative.

We have also, during a number of seasons, tried the effect of still further increasing the nitrate to 6 cwt. per acre, but without finding any advantage.

TRIPOLI (WINTER) ONIONS.

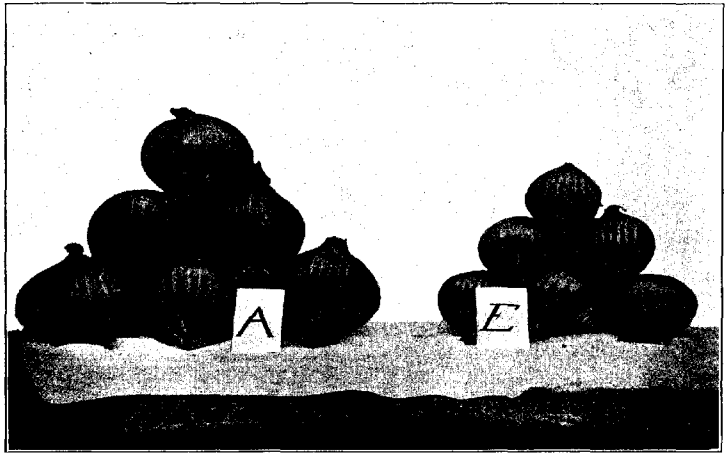
Annual manuring per acre.	Average annual cost of manure per acre.	Average annual yield of onions per acre. (Fourteen seasons.)
	£ s. d.	tons cwt.
50 loads (25 tons) London Dung . .	10 0 0	14 15
25 loads (12½ tons) London Dung . .	5 0 0	10 5
25 loads London Dung, Phosphates (no Potash Salts), and 2 cwt. Nitrate of Soda	7 0 0	13 13
Do., do., with Potash Salts . . .	7 10 0	15 6
25 loads London Dung, Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	8 2 0	14 19
Do., do., with Potash Salts . . .	8 12 0	15 18
No Dung; Phosphates (no Potash Salts) and 8 cwt. Nitrate of Soda *	5 6 0	4 0
Do., do., with Potash Salts . . .	5 16 0	10 2

Our attempt to grow Tripoli onions without stable manure has been on the average successful, to the limited extent that the crop has been nearly as good as that obtained with the light dressing of dung alone; but, having regard to the much larger crops obtainable by the use of a mixture of dung and chemical fertilisers, it is obviously not a mode of manuring to be recommended.

It is interesting to notice that Tripoli onions appear to be very dependent upon a liberal supply of potash. In the case of the plots to which no stable manure has been applied, the yield has averaged over 9½ tons per acre on the potash-dressed plot, but has been little over 4 tons, or considerably less than half, on the plot from which potash salts have been withheld, notwithstanding the free application of phosphates and nitrate. Furthermore, it will be seen that, even in the presence of a dressing of stable manure, potash salts have produced a uniformly good effect. The ability of the plant to avail itself of the natural potash resources of the soil varies, no doubt, at different stages of its growth, and the effect of an insufficient supply of potash may therefore make itself felt

* 4 cwt. only the first 4 years

FROM A SPECIMEN CROP OF TRIPOLI ONIONS.



Crop, 11 tons 6 cwt. per acre.

Manure per acre—
12½ tons London Dung,
4 cwt. Superphosphate,
1 cwt. Nitrate of Soda

(cost £6 per acre)

Crop, 6 tons 7 cwt. per acre.

Manure per acre—
12½ tons London Dung

(cost £5 per acre).

differently in different seasons, according to the incidence of any spell of dry weather at a critical period. This was strikingly demonstrated by a comparison of the continuously undunged plots in one of our earlier seasons (1900). In that year, by the aid of 6 cwt. of superphosphate, 1 cwt. of sulphate of potash, and the somewhat heroic quantity of 8 cwt. of nitrate of soda per acre, we raised 10¼ tons per acre of Tripoli onions without any dung at all, on land which had not been dunged for many years previously—the crop being a sound and marketable one. But on the other half of the plot, which received no sulphate of potash but was otherwise similarly treated, the plants in this particular season failed to produce any bulbs at all worth pulling or weighing. This result was striking as an illustration, though perhaps a somewhat extreme one, of the uselessness of applying liberal dressings of nitrate of soda, or any other nitrogenous manure, to a crop which has not at its disposal the other constituents (phosphates and potash) required for its growth, in sufficient quantity and in such a condition that the individual habits of the crop enable it to utilise them.

The behaviour of onions, and especially Tripoli onions, with regard to potash, is in striking contrast with that of plants of the cabbage kind, which, although some of them are the better for potash, can nevertheless still flourish year after year, provided that they are supplied with phosphates and nitrate, on soil which, although yielding, to these plants, sufficient potash for healthy sustenance, is incapable of growing regular crops of onions, carrots, parsnips, or beetroots, without artificial supplies of potash.

RECOMMENDATION as to Manuring of TRIPOLI (WINTER) ONIONS.

We would advise a moderate dressing of stable manure (25 loads or 12 to 13 tons per acre), with 4 to 6 cwt. of superphosphate, or its equivalent in other phosphatic manure, and 1 cwt. of sulphate of potash or 4 cwt. of kainit per acre. These manures should be well worked into the ground during the preparation of the bed. The crop should then be top-dressed in the spring with 4 cwt. of nitrate of soda per acre, given in two dressings about a month apart. The exact time of the application will be governed, as in other cases, by the soil and season.

LEEKS.

We have grown leeks for thirteen seasons, on a plan of experiment differing somewhat from the scheme followed in most of our other trials,

inasmuch as it includes a plot treated with chemical fertilisers without the use of nitrate of soda. This plan was adopted on account of our experience with leeks in earlier seasons, which seemed to indicate that these plants are less influenced by nitrogenous manure than most of those on which we have experimented. As will be seen from the following results, our earlier experience has been confirmed.

LEEKS.

Annual manuring per acre.	Average annual cost of manures per acre.	Average weight per plant. Thirteen seasons.
	£ s. d.	oz.
50 loads (25 tons) London Dung . .	10 0 0	10·9
25 loads (12½ tons) London Dung . .	5 0 0	10·4
25 loads Dung, Phosphates and Potash Salts (no Nitrate of Soda)	6 8 0	11·2
25 loads Dung, Phosphates, Potash Salts, and 1 cwt. Nitrate of Soda	6 19 0	11·1
25 loads Dung, Phosphates, Potash Salts, and 2 cwt. Nitrate of Soda	7 10 0	11·2
25 loads Dung, Phosphates, Potash Salts, and 4 cwt. Nitrate of Soda	8 12 0	10·4

The leeks have been singled out equidistantly, so that there was the same number of plants on each plot.

It will be seen that there is an appreciable average difference in size between the leeks grown with light dung and those grown with heavy dung, but that chemical fertilisers have exercised more influence on the weight of the crop, at a much smaller cost. Where, however, a moderate quantity of dung has been applied, the inclusion of nitrate of soda in the dressing has not, on the average, given any better results than were obtained by the use of phosphates and potash salts without it. Some later trials on another part of the field tend to indicate that leeks cannot be grown satisfactorily without dung on our soil even with a lavish application of chemical fertilisers, and confirm the apparent indifference of the crop to the influence of nitrate.

ASPARAGUS.

Asparagus is usually supposed to grow best on light, sandy soil, and many experienced growers of this valuable crop would probably, after an initial inspection of our experimental field, have pronounced its growth on such close clayey soil to be impracticable. Nevertheless, on a plantation which

has borne for twelve years we have grown a yearly average of 2000 bundles per acre, while during the best period of bearing the yield has been as high as 3000 bundles per acre.

We constructed our beds in 1895 by cutting deep trenches the width of ordinary asparagus beds, wide enough to contain three plants abreast. A portion of the lowermost clay subsoil was removed, and replaced with brick rubble and old hop bine, for drainage purposes. The upper subsoil was then replaced, being liberally mixed, in the case of all the beds, with stable manure, the surface soil being then replaced above this. Each of our six plots (each being one-hundredth of an acre in area) contains three beds, and in their initial making 40 loads of stable manure were put into the subsoil of the eighteen beds, which is at the rate, roughly speaking, of 300 tons per acre. It is to be borne in mind that this stable manure was buried in the subsoil.

The variety of asparagus chosen was Sutton's "Palmetto." The plants, three years old, were planted in April, 1895. During the first year we were unfortunate enough to lose a considerable number of plants owing to summer drought, and these had to be replaced in 1896. We commenced regular cropping in 1897, and continued down to the season of 1908, when the plantation, which was showing signs of wearing out, was grubbed.

Our manuring has been on the same general principles as on the other plots. One plot receives annually a heavy dressing of stable manure, one a light dressing, and three plots receive a light dressing of stable manure with the addition of chemical fertilisers; while one plot receives chemical fertilisers without any dung.

Since asparagus has the reputation of being a salt-loving plant, we have treated one half of each plot, including those receiving stable manure alone, with salt, in order to test its effect. On the chemically manured plots the salt has been applied in each case to the half-plot which receives no potash salts. The potash applied to the other half of each chemically manured plot has been given in the form of kainit, which contains a good deal of salt. The quantity of salt used has been 2 cwt. per acre on the salt plots, while the kainit on the potash plots has been at the rate of 4 cwt. per acre.

For the first three crops nitrate of soda was used at the rate of 1 cwt., 2 cwt., and 4 cwt. per acre on the plots treated with dung and chemical fertilisers. Since 1899 the same plots have received respectively 2 cwt., 4 cwt., and 6 cwt. of nitrate per acre; while on the plot to which no dung has been applied as a surface dressing the nitrate has been increased to 8 cwt. per acre.

The value of a crop of asparagus depends not only upon the number

of shoots or bundles cut from it, but also upon their size or weight and upon their quality. All of these factors—numerical quantity, weight, and quality—are not necessarily controlled by the system of manuring. The asparagus on our beds is cut every day during the season by an experienced gardener, who cuts each shoot just when it is in full condition for market, the shoots cut from each of the beds being at once placed in a separate receptacle, the respective contents of the receptacles being forthwith counted and weighed. The judgment of the gardener has to be exercised, however, towards the end of the season, in deciding how many shoots shall be left uncut on each crown, to grow and form the foliage by which the plant carries on its life and builds up its strength to send up the shoots of the following season. Sometimes it may seem desirable to leave more shoots on one plant than on another. In order to preserve the bed in good condition, the gardener must exercise his discretion in this regard as well as he can, but he may obviously underestimate the strength or vigour of one plant or crown, or he may overestimate that of another, and leave to one crown fewer shoots than he should, and to another more than he need. The exact number of shoots, however, cannot very easily be regulated. It follows that the quantity of asparagus cut for market on one bed may for these reasons be more or less than that cut on a neighbouring bed, and this will effect the numerical yield of bundles per acre. Moreover, the number of shoots left on any particular crown may well influence the vigour and vitality of the plant as a whole during the growing season, in such a way as to affect the number of marketable shoots thrown up for cutting during the next season. Although every care is exercised to treat the beds as uniformly as circumstances will allow, there is nevertheless apt to be considerable variation in the number of shoots left to grow, and this must have an influence on the mere question of the number of bundles produced by any bed in an individual season. Furthermore, as has been already stated, some of the plants failed owing to drought in the early history of the plots, and had to be replaced by new ones, so that the average age of the plants on all the beds is not quite the same, and this, no doubt, will have produced a little influence in the earlier, though not much in the later, years. The *mere number of bundles* produced on a bed, therefore, is not to be taken as being necessarily the direct effect of the mode of manuring adopted, nor is it necessarily a good index by which to judge the value or quality of the crop. Many of the shoots produced on any bed are always thin and small, and a plant throwing up a number of thin shoots may be less valuable for market purposes than one throwing up a few strong shoots. Our records of total bundles

include all shoots cut, but there is on every asparagus bed a certain proportion of thin stuff which has to be sold at a small price compared with that obtained for bundles of more substantial size. In judging, therefore, of the effect of manuring, we must have regard to the actual *size* of the shoots, expressed as average weight per bundle, as well as to the actual number of bundles grown. We have therefore expressed our results in all cases in three forms, namely, the total weight per acre gathered on each plot, the number of "bundles," and the weight per "bundle" in ounces. When we speak of a "bundle," we mean a bundle of 50 shoots, which is the ordinary unit of the market.

Our results are to be considered under several heads. Perhaps one of the most interesting is that relating to salt.

Effect of Salt.—The following summary shows the average results obtained, over twelve seasons, with and without salt, on the dunged plots receiving no other fertilisers :—

ASPARAGUS.

(Twelve seasons.)

Annual manuring per acre.	Gross weight per acre.	Bundles per acre.	Weight per bundle.
	cwt.		oz.
50 loads London Dung, WITH 2 CWT. SALT	17·0	1744	17·4
50 loads London Dung, WITHOUT SALT	17·1	1765	17·0
25 loads London Dung, WITH 2 CWT. SALT	17·4	1745	17·3
25 loads London Dung, WITHOUT SALT	17·1	1740	17·1

The influence of salt, therefore, appears to have been inconsiderable.

Effect of Potash Salts.—As kainit contains a good deal of salt, we can, by comparing the salt and kainit plots, estimate the effect produced by potash as apart from salt. This is seen in the following table :—

ASPARAGUS.

	First three seasons.			Last nine seasons.		
	Gross weight per acre.	Bundles per acre.	Weight per bundle.	Gross weight per acre.	Bundles per acre.	Weight per bundle.
	cwt.		oz.	cwt.		oz.
Dunged plots, without Potash Salts . . .	12·5	1174	19·1	18·0	1855	17·0
Do., do., with Potash Salts	14·9	1306	20·4	18·7	1944	16 9
Chemical fertilisers only, without Potash Salts .	11·2	1040	19·3	15·7	1577	17·3
Do., do., with Potash Salts	14·1	1168	21·7	16·7	1650	17·8

On the whole the results appear to show that potash is a useful fertiliser for asparagus, and one which should not be omitted if the best results are to be obtained. Its effect has been less marked during the later than during the earlier period of growth on our beds, but this feature it has in common with the other fertilisers which we have used, of which we now proceed to speak.

General Effect of Chemical Fertilisers as an adjunct to or substitute for Stable Manure.—The following table shows the average crop of asparagus produced during the first three seasons on each of our plots. For simplicity's sake the salt or non-potash plots are omitted.

ASPARAGUS.

First three seasons (1897-1899).

Plot.	Annual manuring per acre.	Average annual cost of manure per acre.	Average gross annual weight per acre.	Average annual number of bundles per acre.	Average weight per bundle.
		£ s. d.	cwt.		ozs.
F	50 loads (25 tons) London Dung	10 0 0	12·9	1296	17·6
E	25 loads (12½ tons) London Dung	5 0 0	13·0	1324	17·3
A	25 loads London Dung, Phosphates, Potash Salts, and 1 cwt. Nitrate of Soda	6 19 0	15·3	1355	19·9
B	25 loads London Dung, Phosphates, Potash Salts, and 2 cwt. Nitrate of Soda	7 10 0	12·4	1073	20·6
D	25 loads London Dung, Phosphates, Potash Salts, and 4 cwt. Nitrate of Soda	8 12 0	17·2	1490	20·7
C	*No Dung*; Phosphates, Potash Salts, and 4 cwt. Nitrate of Soda	3 12 0	14·6	1168	21·7

During these first three seasons the effect of chemical fertilisers in increasing the size of the shoots, as compared with those grown with stable manure, was most marked, and though, for reasons already discussed, too much stress must not be laid upon the number of bundles produced per acre, it is nevertheless worth noting that the most liberal treatment—namely, that on plot "D"—gave the best results in numerical quantity as well as in weight.

After the first three years, as the plant became more vigorous, and its demand for food presumably greater, we increased the supply of nitrate of

soda on each plot, and this treatment was continued for the last nine years, with the following results:—

ASPARAGUS.

(Last nine seasons—1900 to 1908.)

Plot.	Annual manuring per acre.	Average annual cost of manure per acre.	Average gross annual weight per acre.	Average annual number of bundles per acre.	Average weight per bundle.
		£ s. d.	cwt.		oz.
F	50 loads (25 tons) London Dung	10 0 0	18·6	1921	16·8
E	25 loads (12½ tons) London Dung	5 0 0	18·4	1878	17·0
A	25 loads London Dung, Phosphates, Potash Salts, and 2 cwt. Nitrate of Soda	7 10 0	18·3	1906	16·8
B	25 loads London Dung, Phosphates, Potash Salts, and 4 cwt. Nitrate of Soda	8 12 0	18·3	1912	16·9
D	25 loads London Dung, Phosphates, Potash Salts, and 6 cwt. Nitrate of Soda	9 14 0	19·5	2014	17·2
C	*No Dung*; Phosphates, Potash Salts, and 8 cwt. Nitrate of Soda	5 16 0	16·7	1650	17·8

Although the total yield of asparagus was much greater throughout the last nine seasons than during the first three seasons—the quantity having actually, in favourable years, risen to as much as 3000 bundles per acre—the increase was mainly in the number of shoots grown, the average weight per bundle being, on the whole, considerably less than during the earlier period of growth. And it will be further noticed that the influence of the artificial fertilisers, when used as an adjunct to stable manure, was on the average much less marked than during the earlier period. This at first sight is a cause of some bewilderment; but the explanation is probably to be found in the fact that, as has been already stated, when the beds were made stable manure was buried in the subsoil at the rate of something like 300 tons per acre; and we think there is little doubt that, during the later period of growth, the roots of the plants have been feeding on the remains of this dung, which, with the annual surface applications of smaller quantities of similar material, has fed the plants sufficiently to make them independent of the artificial dressings,

except in the case of the chemically-manured plot to which no dung has been applied as top dressing. No doubt the retentive nature of our subsoil has tended to conserve the fertilising matter buried therein to a greater extent than would be the case with a more open soil, such as those on which asparagus is more commonly grown. We thought it well, however, not to disturb the beds until the plantation had run its normal course, and we therefore allowed the plants to go on as long as they increased or maintained their vigour; but when, in the season of 1908, we found that not only the number but the size of the shoots showed signs of diminishing vigour, we decided to grub the plants, and, as has been said, a new plantation was made, on which the same modes of treatment are being continued, except that the beds have not been opened up more than spade deep, and that no further manure has been put into the subsoil.

RECOMMENDATION as to Manuring of ASPARAGUS.

In endeavouring to frame general recommendations as to the manuring of asparagus, we think that the experience most likely to translate itself into general application would be that derived during the earlier history of our plantation. We are disposed to recommend a light annual dressing of stable manure, not exceeding 25 loads (12 to 13 tons) per acre, supplemented by a dressing of from 4 to 6 cwt. of superphosphate or other suitable phosphatic manure, 4 cwt. of kainit (or 1 cwt. of sulphate of potash), and 4 cwt. of nitrate of soda per acre. The phosphatic manure and the potash salts should be applied in the winter, and the nitrate of soda in early spring.

It should be noted that the direct effect of the manure is probably not to feed the shoots that are cut for market, but to encourage a vigorous season's growth in the vegetative shoots that are allowed to come to maturity after the cutting season is over. It is presumably owing to the metabolic processes carried on during this period that the plant stores up in its roots the nutriment necessary for producing, at the beginning of the following season, a rapid and vigorous growth of the shoots which constitute the crop.

It has been already pointed out that, on soils poor in lime, it is not advisable to use superphosphate too often. It is better in such cases to use some non-acid phosphatic manure, such as basic slag, or Peruvian guano, or bone meal, or the neutralised or so-called "basic" superphosphate. In the case of asparagus, however, the use of manures of low

solubility or slow diffusibility such as we have mentioned is attended by certain disadvantages, inasmuch as the manure must always be applied at the surface, and cannot be dug in to any great depth, as it can in the case of crops for which the soil is freshly cultivated every year. For this reason, in constructing an asparagus bed on a soil naturally poor in lime, we should be inclined, during the construction and trenching of the bed, to incorporate with both soil and subsoil a quantity of either basic slag or bone meal—as much as would be used collectively in several years' ordinary annual dressings—in order that the roots might find phosphatic nourishment in every layer of soil. Where, however, there is sufficient lime in the soil, an annual dressing of superphosphate is probably all that need be given in the way of phosphatic manure.

In asparagus culture, as in the case of other crops, the market grower will probably like to vary the nature of his artificial or concentrated fertilisers from time to time, on which question, however, the reader is referred back to our introductory chapter.

No advantage has been found, in our experiments, from the use of salt for asparagus. If on any soil salt has any useful functions as an asparagus manure, it can be very well supplied with potash, by using kainit.

LEGUMINOUS CROPS.

THE great discovery of the power of leguminous plants to assimilate free nitrogen from the air through the medium of the micro-organisms inhabiting the tubercular nodules found on their roots, has led many teachers of agricultural chemistry to assume that the supply of nitrogen thus naturally obtainable is necessarily and in all cases sufficient to enable such plants to dispense altogether with the aid of nitrogenous manure. In some cases—as, for instance, when a crop like Red Clover is grown in the course of an ordinary four-crop rotation—such a view is no doubt well grounded. Not, however, because clover neglects to avail itself of manurial nitrogen existing in the soil. Indeed, it has been abundantly proved by the Rothamsted investigations that red clover, as well as other kinds of clover, feeds freely upon nitrogen in the form of nitrates. The residues, however, of the dung and other nitrogenous manures applied to other crops in the rotation are probably generally sufficient, together with the large quantity of free nitrogen which the crop absorbs for itself from the air, to enable it to grow to perfection.

No doubt the degree to which leguminous crops are benefited by or indifferent to direct applications of manurial nitrogen depends to a

considerable extent upon whether the micro-organisms necessary for the tubercular formation and for free nitrogen assimilation are present in the soil in sufficient abundance, and upon whether the circumstances are such as to encourage their free development.

It having come to our knowledge that both in Spain and in America nitrate of soda had been freely and profitably used in the cultivation of Lucerne, or "Alfalfa," we had the curiosity about eighteen years ago to lay down four plots of land with Lucerne by the side of our market-garden crops, manuring them with mineral manures with and without the addition of nitrate of soda.

The first plant laid down lasted until 1904, when it was grubbed and a new sowing made. Altogether we have taken twelve crops, the results of which are set forth in the following table:—

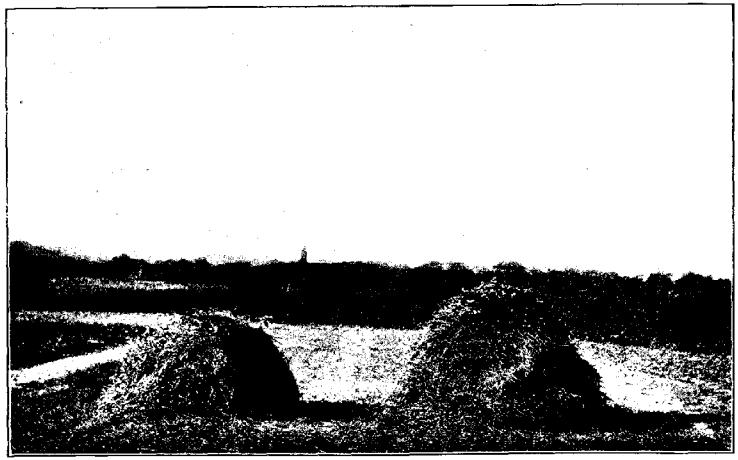
LUCERNE.

Twelve seasons.

	Manured annually with			
	Phosphates and Potash Salts (No Nitrate of Soda).	Phosphates, Potash Salts, and 1 cwt. Nitrate of Soda.	Phosphates, Potash Salts, and 2 cwt Nitrate of Soda.	Phosphates, Potash Salts, and 4 cwt. Nitrate of Soda.
	Total green fodder per acre.			
	tons cwt.	tons cwt.	tons cwt.	tons cwt.
Season 1897 .	3 1	2 19	3 10	3 17
1898 .	11 16	13 11	14 14	13 4
1899 .	14 14	19 15	21 5	17 16
1900 .	11 11	15 9	17 3	17 3
1901 .	15 14	19 3	23 0	22 2
1902 .	18 1	22 11	23 13	22 19
1903 .	17 0	17 10	19 18	17 8
1905 .	5 14	6 17	7 18	7 11
1906 .	10 3	11 16	12 18	12 11
1907 .	14 9	15 3	14 14	16 7
1908 .	13 11	15 1	15 4	16 9
1909 .	14 7	17 1	15 14	18 5
Average total green fodder per acre (twelve seasons)	12 10	14 15	15 16	15 9
Average annual cost of manure per acre	£1 8 0	£1 19 0	£2 10 0	£3 12 0

These results practically corroborate, as regards the effect of nitrogenous manuring, the results of the Lucerne experiments carried out by Dr. Voelcker on smaller plots at Woburn, showing that Lucerne is capable of responding freely to the application of nitrogenous manure. The increase

LUCERNE, 1901 (showing the first cutting of the Season).



Total season's crop, 15 tons 13½ cwt. per acre.

Manure per acre—

6 cwt. Superphosphate,
1 cwt. Sulphate of Potash,
No Nitrate.

Total season's crop, 22 tons 19 cwt. per acre.

Manure per acre—

6 cwt. Superphosphate,
1 cwt. Sulphate of Potash,
2 cwt. Nitrate of Soda.

was much greater in the earlier than in the later years, but it will be seen that, on the average of the twelve seasons, 1 cwt. of nitrate of soda per acre, used in conjunction with phosphates and potash salts, gave an increase of 2¼ tons of green Lucerne per acre, while 2 cwt. of nitrate has given an average of 3¼ tons, no advantage being obtained beyond this.

Our experience with Lucerne led us to make some experiments to see whether nitrogenous manure in the form of nitrate of soda would have, in ordinary market garden practice, any appreciable value for some of the ordinary vegetable crops—peas or beans belonging to the same family. The results of our experiments up to the present are here given.

DWARF FRENCH BEANS.

We have grown this crop for twelve successive years with and without nitrate of soda. The companion plots have each year received 25 loads (12 to 13 tons) per acre of stable manure, with 6 cwt. per acre of superphosphate (varied from time to time by the use of basic slag), and a dressing of potash salts—kainit and sulphate of potash alternately. One of the two plots has annually been dressed in addition with 2 cwt. per acre of nitrate of soda, while the other has had no nitrate. The following table shows the average results of our twelve years' experience:

DWARF FRENCH BEANS.

Twelve seasons.

Annual manuring per acre.	Average annual cost of manure per acre.	Average annual weight per acre of green beans as picked for market.	Average annual weight per acre of haulm harvested as straw.
	£ s. d.	lbs.	lbs.
25 loads (12½ tons) London Dung, Phosphates, and Potash Salts (no Nitrate of Soda)	6 8 0	7490	4100
25 loads (12½ tons) London Dung, Phosphates, Potash Salts, and 2 cwt. Nitrate of Soda	7 10 0	8575	4810

The individual bean pods were plucked green day by day as they attained what was considered to be the best market size and condition, the produce from each plot being weighed daily.

In the twelve seasons thus averaged there was only one in which there was not a substantial advantage from the use of nitrate of soda. The average increase over the twelve seasons was something like 18 per cent., but in some individual years the advantage has been much greater.

SCARLET RUNNERS.

We have grown Scarlet Runners under exactly similar conditions for eight years, and in several individual seasons have had a substantially larger crop on the nitrated plot than on the other. Sometimes, however, the advantage has lain in the other direction, and on the average of years no advantage has been shown in the quantity of beans marketed, although the larger average yield of haulm indicates an appreciable effect from the nitrate on the growth of the plant. It is curious that, with plants so nearly akin as Dwarf French Beans and Scarlet Runners, the manure which has told so well in the one case should have produced so comparatively small an effect in the other.

SCARLET RUNNERS.

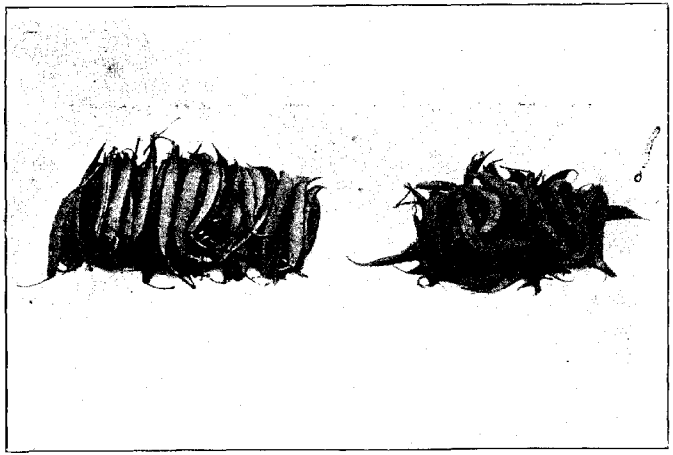
Ten seasons (1902-1911).

Annual manuring per acre.	Average annual cost of manure per acre.	Average annual weight per acre of green beans as picked for market.	Average annual weight per acre of haulm harvested as straw.
	£ s. d.	lbs.	lbs.
25 loads (12½ tons) London Dung, Phosphates, and Potash Salts (no Nitrate of Soda)	6 8 0	13,230	7470
25 loads (12½ tons) London Dung, Phosphates, Potash Salts, and 2 cwt. Nitrate of Soda	7 10 0	13,420	7930

GREEN PEAS.

We have made similar trials with Green Peas for ten years, using various well-known market varieties. In three or four of the seasons there appeared to be a substantial advantage in the yield of peas from the use of nitrate of soda, but over the ten seasons the average yield from the two modes of manuring has been practically the same. The results are shown in the table on p. 123.

On the other hand, however, careful tests repeatedly made of the quality of the peas, by cooking specimens of the produce from each plot separately under the same conditions, have resulted in the observation that the peas manured with nitrate of soda have been, when



Crop, 4 tons 6 cwt. per acre.

Manure per acre—
12½ tons London Dung,
6 cwt. Superphosphate,
4 cwt. Kainit,
2 cwt. Nitrate of Soda

(cost £7 5*s*. per acre).

Crop, 2 tons 13 cwt. per acre.

Manure per acre—
12½ tons London Dung,
6 cwt. Superphosphate,
4 cwt. Kainit,
No Nitrate of Soda

(cost £6 5*s*. per acre).

cooked, distinctly softer, sweeter, and of brighter colour than those grown without the use of nitrate.

GREEN PEAS.

Eleven seasons.

Annual manuring per acre.	Average annual cost of manure per acre.	Average annual weight per acre of green peas in pod as picked for market.	Average annual weight per acre of haulm harvested as straw.
	£ s. d.	lbs.	lbs.
25 loads (12½ tons) London Dung, Phosphates and Potash Salts (no Nitrate of Soda)	6 8 0	6505	5195
25 loads (12½ tons) London Dung, Phosphates, Potash Salts, and 2 cwt. Nitrate of Soda	7 10 0	6510	5040

FRUIT CROPS.

THE manuring of fruit crops of all kinds is a very much more difficult subject to investigate than the manuring of vegetables. In the latter we are usually concerned with the increase of the whole plant, or of the root. In the case of fruit we are concerned not with the development of the plant itself, but with its transient annual product. A treatment which feeds the plant and stimulates its general growth does not necessarily encourage the production of fruit. Indeed, it is a familiar observation that a tree or a plant in what appears to be poor condition will sometimes, in a given season, yield much more fruit than one which, vegetatively, appears to be far more flourishing. In some years manuring appears to be of little effect either way, as far as fruit production is concerned, and what seems in one season to have been an injuriously large application of manure (so far as fruit production is concerned) may in another year prove to be an advantageous and even an insufficient application. A timely fall of a few inches of rain, or even a timely cessation of rain for a few days, or a few daily hours of sunshine, or a lack thereof, at a critical period may be fraught with more consequence than the most carefully calculated scheme of manuring, and every one knows how the yield of a season may be affected by a single late frost.

All these things must be borne in mind in regarding and comparing the results obtained by various methods of manuring fruit plants. It is

only by a general survey of the results obtained over a series of years that any general conclusions can safely be drawn, and sometimes even then only tentative conclusions or recommendations are warranted. It is hoped, however, that even in these cases our work will be of assistance to those who wish to make trials for themselves on their own plantations.

The Duke of Bedford and Mr. Spencer Pickering, F.R.S., have also been for a number of years engaged in experiments on the manuring of bush-fruit, strawberries, and fruit-trees at their Woburn Experimental Fruit Farm, near Ridgmont, and their experience, up to the end of the first eight years, was given in their fourth annual report (1904), and supplemented by further observations in their fifth report (1905). Their plan of experiments has not been on altogether the same lines as our own, but, as far as the results are comparable, they tend in some directions to agree with, and in others to differ from, our own; and like our own, they illustrate the complexity and difficulty of the problems involved in this kind of investigation.

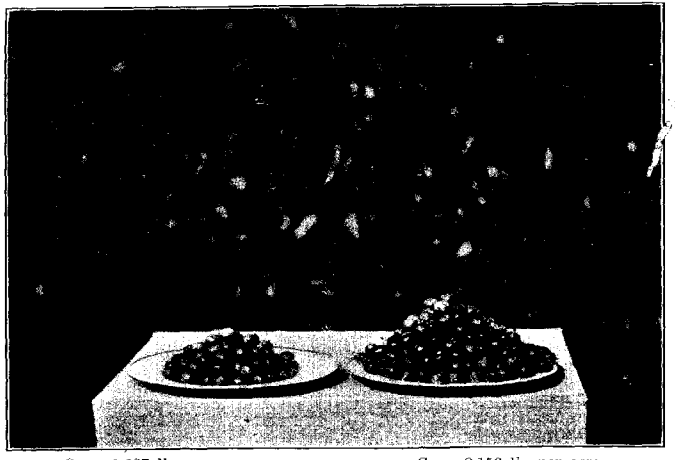
GOOSEBERRIES.

A PLANTATION of Gooseberries (variety, "Whinham's Industry") was laid down in 1898, and this plantation lasted until 1908, when it was grubbed and fresh bushes (variety, "Keepsake") were put in.

We have suffered in some seasons from insect ravages—the crop in 1905, for instance, having been completely destroyed by caterpillars. We have, however, gathered twelve crops, the gooseberries being in some seasons allowed to ripen, but being more often picked in a green or intermediate state. The experiments were conducted on the same lines as in the case of the majority of our vegetable crops, and on a similar series of plots, each full plot being one-fiftieth of an acre in area. Each full plot contains 24 bushes; where the plots are sub-divided into potash and non-potash plots, there are 12 bushes on each plot.

The results that we have obtained up to the present as regards yield of fruit are shown in the table on page 127.

It will be seen that the heavy dressing of stable manure has done much better than the light dressing, but that the average yield from the heavy dressing of dung has been exceeded on one of the plots receiving chemical fertilisers in conjunction with a moderate dressing of



Crop, 1,037 lb. per acre.
Annual manure per acre—
12½ tons London Dung
(cost £5 per acre).

Crop, 2,150 lb. per acre.
Annual manure per acre—
No Dung,
4 cwt. Superphosphate,
1 cwt. Sulphate of Potash,
4 cwt. Nitrate of Soda
(cost £3 per acre).

stable manure. On the other hand, the plot receiving chemical fertilisers alone, although its crop has often been larger than that grown with the smaller dressing of stable manure, has been much behind the plots on which the two modes of manuring have been combined.

GOOSEBERRIES.

Plot.	Annual manuring per acre.	Average annual cost of manure per acre. £ s. d.	Average annual weight of gooseberries per acre. Twelve seasons. lbs.
F	50 loads (25 tons) London Dung .	10 0 0	5000
E	25 loads (12½ tons) London Dung	5 0 0	3750
A	25 loads Dung, Phosphates (no Potash Salts), and 1 cwt. Nitrate of Soda	6 9 0	3850
	Do., do., with Potash Salts . .	6 19 0	4600
B	25 loads Dung, Phosphates (no Potash Salts), and 2 cwt. Nitrate of Soda	7 0 0	3300
	Do., do., with Potash Salts . .	7 10 0	5220
D	25 loads Dung, Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	8 2 0	3960
	Do., do., with Potash Salts . .	8 12 0	4600
C	*No Dung*; Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	3 2 0	860
	Do., do., with Potash Salts . .	3 12 0	2370

Although on the average the "B" plots, receiving 2 cwt. of nitrate of soda per acre in conjunction with stable manure and phosphates, have given better results than the "D" plots, with 4 cwt. of nitrate, this difference has been mainly due to the yields in recent abundant seasons. During most of this time the yields on the "D" plots have been better.

Obviously one of the most striking points brought out in the experiments is the influence of potash salts on gooseberries. On the plot to which no dung is applied, the average crop has been nearly trebled by the use of potash salts, and, indeed, in some years, the non-potash plot has almost refused to produce a crop at all. This is not remarkable; but it is remarkable that, even on the plots receiving every year 25 loads of stable manure per acre, potash salts should consistently produce so steady

	Black Currants.	Red Currants.
Average annual **increase** of Currants per acre over eight seasons, obtained by supplementing 25 loads of stable manure per acre with phosphates, potash salts, and 4 cwt. nitrate of soda per acre . . .	616 lbs.	215 lbs.
Average **increase** obtained by increasing the 25 loads of stable manure per acre to 50 loads	427 ,,	130 ,,

The influence of potash, except on the plots receiving no stable manure, has not been so marked or so regular as in the case of gooseberries, and is not brought out consistently over the average of seasons; but in individual seasons the good effect of potash has been sufficiently evident throughout the plots to make it appear that it would not be prudent to omit this constituent from a mixed dressing, even when stable manure is used in only moderate quantity.

It is interesting to note that, in the case of the red currants, a full crop has been obtained in several seasons on the plot to which no stable manure at all has been applied, where potash salts have been given in conjunction with phosphates and 4 cwt. of nitrate of soda per acre. The yield on the corresponding plot of black currants, on the other hand, has throughout been below a full crop.

RASPBERRIES.

Raspberries are a difficult crop for quantitative experiments, as it is not easy to regulate at the same time the number of plants and the number of "canes" springing from them in such a way as to get uniformity of growth throughout the plots, even when these are of so large an area as one-fiftieth of an acre. Our crops have varied very much in different years, and our average experience, deduced from the crops gathered in eight seasons, is that a moderate manuring appears to be sufficient for Raspberries. Our average results were as follows:—

RASPBERRIES.

Plot.	Annual manuring per acre.	Average annual cost of manure per acre. £ s. d.	Average annual weight of raspberries per acre. **Eight seasons.** lbs.
F	50 loads (25 tons) London Dung .	10 0 0	2060
E	25 loads (12½ tons) London Dung .	5 0 0	2400
A	25 loads London Dung, Phosphates (no Potash Salts), and 1 cwt. Nitrate of Soda	6 9 0	2240
	Do., do., with Potash Salts . .	6 19 0	2180
B	25 loads London Dung, Phosphates (no Potash Salts), and 2 cwt. Nitrate of Soda	7 0 0	2125
	Do., do., with Potash Salts . .	7 10 0	2000
D	25 loads London Dung, Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	8 2 0	2230
	Do., do., with Potash Salts . .	8 12 0	2425
C	*No Dung*; Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	3 2 0	1420
	Do., do., with Potash Salts . .	3 12 0	1670

Not merely on the average, but in every year but two, the lightly dunged plot has given a heavier crop of raspberries than the doubly dunged plot, so that there appears to be no advantage in heavy dunging; and on the average the addition of chemical fertilisers to the light dressing of stable manure has not been productive of advantage, although in seven out of eight seasons, taken individually, the use of chemical fertilisers, including phosphates, potash salts and nitrate of soda, either with or without stable manure, has on one or other of the plots produced a substantially better yield than dung alone.

The non-potash part of plot "C" now only produces stunted and obviously unhealthy canes.

RECOMMENDATION AS TO MANURING OF BUSH FRUITS.

We think we can with a fair amount of confidence recommend for Gooseberries a light annual dressing of stable manure (25 loads, or 12 to 13 tons per acre), with 4 to 6 cwt. of superphosphate, 1 cwt. of

sulphate of potash, and 4 cwt. of nitrate of soda per acre. It appears to be especially important for this crop that potash salts should not be omitted. On soils poor in lime, basic slag may replace superphosphate, or may take its place in alternate years.

We consider that a similar scheme of manuring may safely be adopted for Currants. The use of stable manure as well as chemical fertilisers appears to be desirable, although Red Currants, as far as our experience goes, appear to do very well under liberal chemical treatment, even in the absence of dung.

A light dressing of stable manure (25 loads, or 13 tons per acre) should, as a rule, be given to Raspberries. The additional application of 4 cwt. of superphosphate, 1 cwt. of sulphate of potash, and 4 cwt. of nitrate of soda will often give a better result than the stable manure alone, but not always.

If it is not convenient to apply dung in any particular year, treatment with phosphates, potash salts, and nitrate of soda in the proportions mentioned may be expected to give a good yield in a favourable season.

VICTORIA PLUMS.

A PLANTATION of Victoria Plums was made in 1898, on a similar scheme of general manuring to that adopted for bush fruits, each plot being one-fiftieth of an acre in area, with eight trees per full plot, or four trees on each of the potash and non-potash halves of the divided plots. Late frosts have several times interfered with the crop, which was too irregular to be of much experimental interest during the first seven years of bearing, and we have, unfortunately, never been quite free from "Silver Leaf." In five out of the last six seasons, however, we have gathered substantial crops, but the yield does not appear to have been consistently affected by the manuring. The plot which has every year received 50 loads of stable manure per acre has not done so well as the plot receiving half this dressing, and the average yield of this plot has been beaten every year by that of one of the plots on which the lighter dressing of dung has been supplemented by chemical fertilisers. On the other hand, by far the largest yield of all has been obtained on the plot to which chemical fertilisers alone have been applied, including an annual dressing of superphosphate or basic slag (alternately), with sulphate of potash (or its equivalent in kainit) and 4 cwt. per acre of nitrate of soda. Our conclusion, so far as our results warrant any, would

be that the most economical way of manuring plums would be to dispense with dung altogether, and to give such a chemical dressing as has been indicated. Potash salts, as well as nitrate and phosphates, must be included in the dressings, for on these plots, manured with chemical fertilisers only, the omission of potash salts has on the average been followed by a reduction of the yield by one-half. Our average results for the five bearing seasons are shown in the following table :—

VICTORIA PLUMS.

Plot.	Annual manuring per acre.	Average annual cost of manure per acre.	Average annual weight of Plums per acre. **Five seasons (1907-1911).**
		£ s. d.	lbs.
F	50 loads (25 tons) London Dung .	10 0 0	3465
E	25 loads (12½ tons) London Dung .	5 0 0	3725
A	25 loads Dung, Phosphates (no Potash Salts), and 1 cwt. Nitrate of Soda	6 9 0	1950
	Do., do., with Potash Salts . .	6 19 0	1855
B	25 loads Dung, Phosphates (no Potash Salts), and 2 cwt. Nitrate of Soda	7 0 0	2680
	Do., do., with Potash Salts . .	7 10 0	1300
D	25 loads Dung, Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	8 2 0	5095
	Do., do., with Potash Salts . .	8 12 0	3560
C	*No Dung*; Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	3 2 0	2870
	Do., do., with Potash Salts . .	3 12 0	6100

The fungoid disease known as "Silver Leaf," to which plum trees are very subject, has during the present year (1913) spread a good deal, and as it is irregularly distributed will necessarily in the future vitiate any conclusions that might be drawn as to the effects of fertilisers on the cropping, so this plantation will have to be eliminated from our experiments.

STRAWBERRIES.

We have experimented over many years on Strawberries on similar lines to those followed with other fruits, and have had a series of five separate plantations. The results of manuring have been very variable, as will be seen from the annexed tabular statement. The "life" of the plantations has also been variable. The first plantation ("President") yielded six crops, and the second ("Paxton") four crops. The third ("Paxton" again) gave us three crops. The fourth ("Royal Sovereign") only lasted for two crops, after which the plant became irregular and had to be grubbed; and the fifth ("President") yielded four crops.

STRAWBERRIES.

AVERAGE ANNUAL YIELD OF FRUIT PER ACRE.

Annual manuring per acre.	President. Six years' average (1895–1900).	Paxton. Four years' average (1898–1901).	Paxton. Three years' average (1903–1905).	Royal Sovereign. Two years average (1906–1907).	President. Four years' average (1908–1911).
	lbs.	lbs.	lbs.	lbs.	lbs.
50 loads (25 tons) London Dung . . .	3416	3248	4816	2996	4270
25 loads (12½ tons) London Dung . . .	4704	2940	4480	3052	2870
25 loads Dung, Phosphates, and 1 cwt. Nitrate of Soda	4592	3024	2184	4130	2400
25 loads Dung, Phosphates, and 2 cwt. Nitrate of Soda	5040	2240	2837	4172	3200
25 loads Dung, Phosphates, and 4 cwt. Nitrate of Soda	4088	2492	2772	3780	3500
No Dung; Phosphates (no Potash), and 4 cwt. Nitrate of Soda	3052	2324	980	378	440
Do., do., with Potash .	3388*	2240†	1848‡	2800§	1430§

* Potash in 1895 and 1896 only.

† No potash applied directly to strawberries, but to three preceding crops.

‡ Potash in 1905 only, but applied regularly for other crops before 1905.

§ Potash every year.

A study of these results, and of the individual seasonal yields of which they show the averages, suggests the following conclusions:—

1st Plantation ("*President*").—Over a period of six years heavy

dunging was detrimental to the yield of fruit as compared with light dunging, and the total yield from the lighter dressing of dung was not much increased by the addition of concentrated fertilisers.

2nd Plantation ("*Paxton*").—Over a period of four years heavy dunging gave rather better results than light dunging. Concentrated fertilisers did not increase the yield, and their use on the whole was accompanied by diminution.

3rd Plantation ("*Paxton*").—Over three years heavy dunging did better than light dunging, and dung alone gave much better results than "mixed" manuring.

4th Plantation ("*Royal Sovereign*").—Over two years heavy dunging gave no better results than light dunging, but in this case the addition of concentrated fertilisers to the lighter dressing of dung gave a very large and remunerative increase.

5th Plantation ("*President*").—Here, over four years, there has been a large advantage from heavy as compared with light dunging. Concentrated fertilisers given in addition to a light dressing of dung have been remunerative when the dressing of nitrate was 2 cwt. or 4 cwt. per acre.

In the table it will be noticed that on the dunged land the chemical dressings recorded are only those composed of phosphates and nitrate of soda without potash. In each year, corresponding potash plots were included, but potash was not given directly to the strawberry crop in all cases. In the case of the first plantation, on which potash salts were given to one-half of each plot for the first two years, their use was followed (except on the plots receiving no dung) by so decided a diminution in the yield of fruit, that we considered there was evidence that their use in conjunction with dung was baneful, and so we discontinued their application, continuing, however, to weigh separately the produce of the potash plots. On the second plantation we also refrained from applying potash salts to the strawberries, but one-half of each chemically dressed plot had received several years' applications of potash for preceding vegetable crops. In this case, the potash plots on the whole showed a slight advantage. On the third plantation the plots that had been previously potash-dressed for other crops were not again dressed in the first two years, but potash dressings were given direct to the strawberries in the third year, and apparently, on this plantation, potash did good. On the last two plantations, potash was given each year to the potash plots—in the latter with some apparent benefit The results are summarised in the following statement:—

AVERAGE OF ALL PLOTS RECEIVING LIGHT DUNG, PHOSPHATES, AND NITRATE OF SODA WITH OR WITHOUT POTASH SALTS.

	Annual yield of Strawberries per acre.	
	Non-Potash Plots.	Potash Plots.
	lbs.	lbs.
1st plantation (6 seasons) . .	4576	3316
2nd ,, (4 ,,) . .	2576	2654
3rd ,, (3 ,,) . .	2587	2822
4th ,, (2 ,,) . .	4032	3886
5th ,, (4 ,,) . .	3030	3210

Our earlier conclusions as to potash salts being deleterious to the plants in presence of dung does not, therefore, seem to have been borne out by later experience. Whether the earlier results were due to seasonal conditions, it is hard to conjecture. As has been already observed, the effect of manurial applications on fruit crops is complicated and obscure, as a given dressing may take effect either on the general vegetative growth of the plant (as, for instance, in the case of strawberries in stimulating the formation of "runners"), or on the production of fruit, and what may tell one way in one season, may tell differently in another. But it seems fairly reasonable to conclude, from our general results, that potash salts are at any rate not a necessary application for strawberries in conjunction with phosphates and nitrate, provided that a light dressing of stable manure is also given.

That potash is a very necessary constituent for the production of a crop of strawberries, however, appears clearly in the main table of results, where it will be seen that on the plots continuously kept without dung the withholding of potash has been very disastrous to the yield during the last nine seasons, although the other main constituents of plant food have been freely supplied. But on the dunged plots the potash contained in a light dressing of stable manure, together with that in the soil, seems to have been sufficient.

So far we have only considered the total yield of fruit. *Earliness* of crop is also an important factor in the valuation of the strawberry crop, and is indeed a matter of greater moment than mere total weight, since the market value of the fruit is greater at the beginning than at the end of the very short strawberry season. During the earlier years of our experiments we found that the plots which received, in addition to a light dressing of dung, a dressing of concentrated fertilisers, including not

more than 2 cwt. of nitrate, gave on an average an earlier crop. A striking instance of this was in 1898, which was the heaviest yielding strawberry year within our experience. In that year we grew over four tons of strawberries per acre on the lightly dunged plot. The plot receiving also phosphates and 2 cwt. of nitrate of soda gave a crop only 3 cwt. per acre in excess of that from dung alone, but in the first few days of picking we gathered from the chemically aided plot at the rate of 700 lbs. more per acre than from the dung-only plot, the value per pound of the strawberries picked during these few days being at least double that of the subsequent gatherings.

During later years we have not observed any uniform advantage in this direction; but, on the other hand, there has been, as we have seen, substantial increase in total yield from the plots receiving moderate chemical aid.

RECOMMENDATION as to Manuring of STRAWBERRIES.

Weighing the whole of our experience, we would not alter the recommendation we ventured tentatively to set forth in an earlier report, viz. that for strawberries a light annual dressing of dung (not more than 25 loads or 12 to 13 tons) should be used in preference to a heavier dressing, the dressing being accompanied by one of 4 to 6 cwt. of superphosphate and 2 cwt. of nitrate of soda per acre, the latter being applied early in the spring.

APPLES.

In 1900–1901 we planted an experimental apple orchard, one acre in extent. This acre is divided into six plots, each of which was planted with five varieties of apple trees (of "pyramid" form), there being on each plot ten trees of each variety, making fifty trees on each plot, or 300 trees in all. The varieties were as follows:—

"Wellington,"
"Red Reinette,"
"Newton Wonder,"
"Bramley's Seedling,"
"Cox's Orange Pippin."

The Wellingtons did not flourish well on any of the plots, being apparently unsuitable to the soil, although originally grafted on similar

stocks to those from which the other trees were formed. These (Wellingtons) were therefore cut back in 1907, and regrafted with Red Reinettes, a variety which was already doing well, so that we have now two sets of this variety, which we call respectively "old" and "regrafted."

The annual manuring of the six plots has been the same as in the case of the other fruit plantations. The ground between the trees has not been cropped, and has been kept dug and hoed to keep grass from growing.

The production of apples on young trees is too irregular and too dependent on chance circumstances to allow it to be regarded as being necessarily an index of the effect of manuring. Sometimes the blossom "sets" well on one tree, with the result of a good show of apples, while its next neighbour, of the same variety and similarly treated, may cast its blossom unset. The direction or exact incidence of the wind on the morning of a late frost may easily influence the yield of a tree or a whole row of trees more than any difference in nutrition. In the earlier years, therefore, the weight of apples may be regarded as of negligible consequence, and even during recent years, when many of our trees have been yielding heavily, the crop has been too irregular to allow of more than broad and tentative inferences as to its dependence on the fertilisers used. A larger number of bearing years must elapse before safe lessons can be drawn.

Meantime it is very obvious that the general growth and well-being of the trees has been largely affected by the manuring, and we sought in 1910 to obtain some index of this by measuring the girth of each tree at the base of the trunk six inches above the earth. In some few cases—but in only a few—owing to an outgrowing branch (the trees, it will be remembered, being "pyramid") the measurement had to be taken a little lower than at six inches. The results of the average measurements of the trees on each plot are tabulated on the opposite page.

APPLES.

AVERAGE GIRTH AT BASE OF TRUNK.

(Measured in 1910—ten years after planting.)

	Annual manuring per acre.	"Wellington" (re-grafted as Reinette").	"Red Reinette."	"Newton's Wonder."	"Bramley's Seedling."	"Cox's Orange Pippin."	Average of all trees on each plot.
		ins.	ins.	ins.	ins.	ins.	ins.
F	50 loads (25 tons) London Dung	12·1	11·2	16·1	15·3	13·6	13·7
E	25 loads (12½ tons) London Dung	11·3	11·3	14·4	13·9	12·8	12·7
A	25 loads London Dung, Phosphates (no Potash Salts), and 1 cwt. Nitrate of Soda	11·8	11·2	14·7	14·8	12·1	12·9
	Do., with Potash Salts .	11·8	10·8	16·9	15·1	14·3	13·8
B	25 loads London Dung, Phosphates (no Potash Salts), and 2 cwt. Nitrate of Soda	12·0	12·4	16·0	15·2	11·9	13·5
	Do., with Potash Salts .	12·8	13·4	16·6	15·5	15·4	14·7
D	25 loads London Dung, Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	12·7	11·6	14·7	14·4	12·9	13·3
	Do., with Potash Salts .	14·0	12·4	16·6	14·7	14·3	14·4
C	*No Dung;* Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	9·1	6·2	11·7	8·6	10·1	9·1
	Do., with Potash Salts .	10·3	9·9	14·2	13·6	13·0	12·2

The eye at once rests on the small figure indicating the girth of the trees on that part of the undunged plot from which potash has been withheld, despite the abundant supply of phosphates and nitrogen. The inferiority in size of all the trees in this area is the feature that immediately strikes the visitor in a walk round the orchard. On the half of this plot on which potash also has been given, the trees are on the average not much more backward in growth than those of the lightly dunged plot "E," but are much behind those receiving, in addition to dung, a moderate dressing of chemical fertilisers, including potash salts as well as phosphates and nitrogen. The omission of potash salts from the mixture, even on the dunged plots, has in almost every case had a retarding effect on the growth, as is indicated by the trunk measurements. In presence of dung,

phosphates and potash salts, 2 cwt. per acre of nitrate of soda has produced a larger growth than 1 cwt.; but 4 cwt. of nitrate has not improved on the growth induced by 2 cwt. The development produced by the double dressing of dung, as compared with the single dressing, has been inferior to that produced by mixed manuring.

The yield of apples per tree during the last five seasons is indicated in the following table :—

APPLES.

MEAN ANNUAL YIELD OF* BEARING TREES OVER LAST FIVE YEARS (1908 to 1912).

(Expressed in lbs. per tree per annum.)

Plot.	Annual manuring per acre.	"Red Reinette."	"Newton's Wonder."	"Bramley's Seedling."	"Cox's Orange Pippin" (two years only).	Average of the four varieties.	Average of four varieties: Yield per acre on basis of 300 trees.
		lbs.	lbs.	lbs.	lbs.	lbs.	cwt.
F	50 loads (25 tons) London Dung	12·7	21·0	27·2	22·6	20·9	56
E	25 loads (12½ tons) London Dung	16·7	30·4	26·6	20·0	23·4	62
A	25 loads London Dung, Phosphates (no Potash Salts), and 1 cwt. Nitrate of Soda	17·6	19·1	20·8	9·6	16·8	45
	Do., with Potash Salts	15·6	24·5	31·7	7·8	19·9	53
B	25 loads London Dung, Phosphates (no Potash Salts), and 2 cwt. Nitrate of Soda	18·9	17·3	34·6	9·3	20·0	53
	Do., with Potash Salts	19·2	20·2	31·1	19·5	22·5	60
D	25 loads London Dung, Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	19·1	27·7	33·5	16·6	24·2	65
	Do., with Potash Salts	20·8	30·1	31·1	13·7	23·9	64
C	*No Dung;* Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	4·6	14·2	4·8	8·1	7·9	21
	Do., with Potash Salts	12·6	24·6	23·7	18·7	19·9	53

The average yields over these five years are still obviously too small—apart from other considerations already mentioned—to allow much stress to be laid on them, and they include the very bad season of 1912 in which the crop was, from an economical point of view, almost negligible. In

* The re-grafted Red Reinettes have not yet come into regular bearing, and the Cox's Orange Pippins only began to bear in 1911.

seasons of low yields the manuring cannot be expected to tell much or consistently. The only very striking feature which the table presents is found in the consistently low average results on the plot kept without stable manure on which potash has been omitted from the chemical fertilisers, as compared with the otherwise similar plot on which potash has been included in the dressings. The difference in fruit yield accords with the difference in development of the trees indicated by the measurements in the preceding table.

A better idea of the capability of the various fertilisers to influence the crop is obtained if, instead of taking the average of five years, we select a season of comparatively heavy bearing, such a season as that of 1911. The following table shows the yields of that year :—

APPLES.

SEASON 1911.

(Expressed in lbs. per tree.)

Plot.	Annual manuring per acre.	"Red Reinette."	"Newton's Wonder."	"Bramley's Seedling."	"Cox's Orange Pippin."	Average of the four varieties.	Average per acre, on basis of 200 trees.
		lbs.	lbs.	lbs.	lbs.	lbs.	cwt.
F	50 loads (25 tons) London Dung	33·4	68·8	80·1	16·9	49·8	133
E	25 loads (12½ tons) London Dung	44·6	65·3	69·8	11·2	47·7	127
A	25 loads London Dung, Phosphates (no Potash Salts), and 1 cwt. Nitrate of Soda	49·4	67·3	62·2	10·4	47·3	126
	Do., with Potash Salts .	36·1	74·4	75·5	6·9	48·2	128
B	25 loads London Dung, Phosphates (no Potash Salts), and 2 cwt. Nitrate of Soda	45·5	64·7	80·9	10·2	50·3	134
	Do., with Potash Salts .	46·9	69·5	83·9	19·4	54·9	146
D	25 loads London Dung, Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	49·4	86·3	67·3	18·0	54·7	146
	Do., with Potash Salts .	49·2	99·2	62·5	9·2	55·0	147
C	*No Dung;* Phosphates (no Potash Salts), and 4 cwt. Nitrate of Soda	15·0	33·9	9·9	9·2	17·0	45
	Do., with Potash Salts .	31·3	53·7	60·3	9·8	38·8	103

The practical reader may ask whether it is not a curious and doubtfully economical proceeding to manure young trees, as we have done, so long before they are mature enough to yield remunerative crops.

The answer is that in ordinary practice bush fruit or vegetables would be grown between the young apple trees during what may be called their "minority," and that incidentally the apple trees would have thus received their share of the manures given to the smaller plants. To have followed this mode of mixed culture, however, would have somewhat complicated the experiments, and we have therefore sacrificed the space between the trees by keeping it fallow, although this has no doubt entailed waste of manure, which has been evenly spread over the whole of each plot.

KENTISH COB-NUTS.

THESE experiments, as well as those on Damsons, were carried out on the fruit farm of our friend and former neighbour, Mr. Godwin, of East Peckham, but we were not able to continue them beyond the season of 1902; for Mr. Godwin gave up his farm, and his successor was not sufficiently interested in the work of our experiments to co-operate in their continuance.

One portion of the plantation was manured in alternate years with 15 cwt. of wool waste per acre, this being the customary mode of manuring practised in this neighbourhood for nuts for many years. During the experimental period of six years this plot was three times thus dressed with wool waste, one plot being left wholly unmanured, and four other plots receiving dressings of phosphates and potash salts with and without various quantities of nitrate of soda; while on one plot the potash salts were omitted, phosphates and nitrate of soda only being applied.

Although the mode of manuring distinctly affected the growth and appearance of the trees, it did not, on the average of the six seasons, produce any very great effect on the actual quantity of nuts yielded per acre.

The results are shown in the table on the opposite page:—

KENTISH COB-NUTS.

Annual manuring per acre.	Average annual yield of Cob-nuts per acre over six seasons (1897 to 1902).
	cwt.
Unmanured since 1896	7
If [illegible] Wool Waste in alternate years	6½
Phosphates and Potash Salts only	6¾
Phosphates, Potash Salts, and 1 cwt. Nitrate of Soda	7
Phosphates, Potash Salts, and 2 cwt. Nitrate of Soda	7½
Phosphates, Potash Salts, and 4 cwt. Nitrate of Soda	7
Phosphates (without Potash Salts) and 2 cwt. Nitrate of Soda	6¾

It will be seen that the greatest average weight of nuts was obtained on the plot receiving a dressing of phosphates and potash salts with 2 cwt. of nitrate of soda per acre.

Where potash was omitted the average crop was not so good, and the same thing was observed where nitrate of soda was omitted.

A more important point, however, than quantity, affecting the market value of Kentish Cob-nuts, is the length of the "beard" or cupule (the calyx-like envelope of the nut). For some reason or other, nuts with a fine "beard" realise a much better market price than others, even though the nuts within may be no larger. Mr. Godwin found that the nuts from the plots manured with phosphates, potash salts, and nitrate of soda realised in the market as much as 5s. per cwt. more than nuts grown merely with wool waste.

Our experiments do not afford any precise information as to what is the most remunerative quantity of nitrate of soda to employ, in conjunction with phosphates and potash salts, for this crop.

DAMSONS.

DAMSONS were grown on precisely the same plan of manuring as the Cob-nuts, and in the same field. This crop is, unhappily, subject to many influences, both general and local, which interfere with its regularity from the experimental point of view. Some of the trees are nearer than others to a hedge, which in certain directions of the wind affords some protection from frost, and this in some critical seasons may largely affect the yield of the favoured trees. Then, again, the birds are great enemies of experiments on fruit, since they will capriciously select some particular trees for attack, while leaving others more or less alone. Then, again, the crop differs enormously in different seasons. For instance, in 1897 our yield averaged about 50 "sieves" per acre; in 1898 over 400 "sieves";

in 1899 about 30 "sieves"; and in 1900 as much as 600 "sieves" per acre. A "sieve," it should be mentioned, is the market weight of 56 lbs.

The season of 1900 was indeed so prolific a one with regard to damsons that the greater part of the crop in many damson orchards was left unpicked and allowed to fall and manure the ground. Our friend Mr. Godwin left the greater part of his damsons unpicked, and, although most of our experimental plots were carefully picked in order to obtain our records, by some misunderstanding the wool waste plot was left unpicked, thus making it impossible to include its results in our four years' average. Its three years' average is, however, given in the table which follows. In 1901 the crop partially failed; and in 1902, owing to a late and severe frost, there were no damsons at all to gather.

The results indicate on the average a great advantage from the use of nitrate of soda in conjunction with phosphates and potash salts; but, owing to the more or less chance influences to which a crop like this is exposed, a longer experience would be necessary before we could form an opinion as to what would, on the whole, be the most favourable quantity of nitrate to use.

DAMSONS.

Annual manuring per acre.	Average annual yield of Damsons per acre.	
	Three years' average.	Four years' average.
	"Sieves" of 56 lbs.	"Sieves" of 56 lbs.
Unmanured since 1896	178	244
15 cwt. Wool Waste in alternate years	177	—
Phosphates and Potash Salts only	104	213
Phosphates, Potash Salts, and 1 cwt. Nitrate of Soda	155	304
Phosphates, Potash Salts, and 2 cwt. Nitrate of Soda	187	295
Phosphates, Potash Salts, and 4 cwt. Nitrate of Soda	197	288
Phosphates (without Potash Salts) and 2 cwt. Nitrate of Soda	165	308

It may be observed that, both for the damsons and for the nuts, the phosphatic dressings used were:—

In 1897, 8 cwt. Superphosphate per acre.
In 1898, 6 cwt. Superphosphate per acre.
In 1899, 6 cwt. Superphosphate per acre.
In 1900, 9 cwt. Basic Slag per acre.
In 1901, 6 cwt. Superphosphate per acre.
In 1902, 6 cwt. Superphosphate per acre.

AFTER EFFECTS OF MANURIAL TREATMENT.

Most of our experiments on vegetables having been repeated sufficiently often to eliminate or average the effect of variations due to exceptionally wet or exceptionally dry seasons, it occurred to us that it would be not devoid of practical interest to cease applying the usual dressings, and to see, from the yields obtained without further manure, how far the subsequent productivity of our various plots might be affected by the very diverse manurial treatment to which they had been subjected. If the reader will turn back for a moment to page 16, and glance at the plan indicative of the general scheme of manuring adopted, he will realise that we have, on each of twenty-six sections of ground, six plots, four being subdivided so as to make ten in all, each of which has been subjected for the greater part of twenty years to some one continuous manurial scheme, but having borne in succession a variety of crops. Thus we have twenty-six plots which, with only occasional intermissions, have received year after year fifty loads of London stable manure per acre, twenty-six plots which have year by year received half that quantity of stable manure, and three times that number which, with the half dressing of stable manure, have received in addition various dressings, light and heavy, of chemical fertilisers, each of these being again subdivided into two. Then there are the twenty-six plots on which no stable or farmyard manure has been used for some twenty years, but which, during all that time, have been fertilised with chemical manures only, these being again each subdivided into two. The duration of the relative fertility accumulated from constant light or heavy dunging appeared in itself an interesting matter for observation, and still more so the subsequent effect of the chemical fertilisers used with or without stable manure. Our readers have become aware of the largely increased yields of bulky vegetable crops taken from our field year after year by means of chemical fertilisers, both with and without the aid of dung, and will have noticed that on many of the plots, in addition to superphosphate and basic slag, nitrate of soda has been used in quantities running up to 6 or 8 cwt. per acre year by year. How far would such long-continued past dressings of potent chemical fertilisers affect the fertility of the soil if their application were to cease? Would their effects cease with the cessation of their application, or would the greatly enhanced fertility which accompanied their use be continued for any length of time for subsequent crops?

It is not uncommon to find both farmers and market gardeners nervous

GROWN IN 1912 WITHOUT MANURE OF ANY KIND.

PREVIOUS Annual Treatment for many Seasons past.	LATE BROCCOLI (Section 7).		EARLY BROCCOLI (Section 19).		CAULI-FLOWERS (Section 12).		CAULI-FLOWERS (Section 21).		BRUSSELS SPROUTS. (Section 11).	CURLED SAVOY CABBAGES (Section 13).		DRUMHEAD SAVOY CABBAGES (Section 14).	
	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.	Sieves of 40 lbs.	tons	cwt.	tons	cwt.
F 50 loads London dung . . .	16	8	15	3	12	10	17	4	294	12	6	8	2
E 25 loads London dung . . .	10	12	13	15	10	0	14	0	126	10	8	5	7
A 25 loads London dung, with phosphates, and 2 cwt. nitrate of soda	13	2	16	6	12	9	14	19	196	14	17	10	12
A Ditto, with potash	13	6	15	17	12	15	14	4	212	16	8	11	7
B 25 loads London dung, phosphates, and 4 cwt. nitrate of soda	14	8	15	15	14	13	17	5	229	17	6	10	11
B Ditto, with potash	14	19	14	5	14	0	17	5	259	18	3	12	3
D 25 loads London dung, phosphates, and 6 cwt. nitrate of soda	17	0	16	5	13	13	19	15	282	20	8	11	7
D Ditto, with potash	17	3	16	13	14	12	21	12	282	22	12	11	18
C No dung, Phosphates and 8 cwt. nitrate of soda	14	1	13	15	13	10	15	16	258	17	11	12	5
C Ditto, with potash	14	3	13	12	11	5	16	14	275	17	6	9	14

GROWN IN 1912 WITHOUT MANURE OF ANY KIND.

PREVIOUS Annual Treatment for many Seasons past.	BEET-ROOTS (Section 9).	PARSNIPS (Section 23).	LATE POTATOES "Up to Date" (Section 10).	MEDIUM POTATOES "Derby-shire Success" (Section 25).	ONIONS (Section 17).	WINTER LETTUCES, 1912-13 (Section 28). (After Unmanured Parsnips, 1912).	CARROTS (Section 24).
	tons cwt.	tons cwt.	tons cwt.	tons cwt.	tons cwt.	tons cwt.	tons cwt.
F 50 loads London dung	7 18	19 0	11 5	6 14	4 5	12 8	17 0
E 25 loads London dung	5 9	12 10	7 9	5 19	2 12	9 4	13 6
A 25 loads London dung with phosphates, and 2 cwt. nitrate of soda	6 15	13 7	8 0	6 9	2 17	10 8	14 18
A Ditto, with potash	8 0	14 7	7 19	7 0	3 19	10 4	14 16
B 25 loads London dung, phosphates, and 4 cwt. nitrate of soda	8 8	15 12	9 0	6 12	4 9	9 11	17 0
B Ditto, with potash	6 16	16 3	9 4	6 11	4 1	9 17	16 14
D 25 loads London dung, phosphates, and 6 cwt. nitrate of soda	7 14	18 8	9 1	6 14	2 13	13 0	18 18
D Ditto, with potash	7 9	19 15	9 3	6 18	4 7	10 14	18 11
C No dung. Phosphates and 8 cwt. nitrate of soda	6 11	9 4	3 8	5 10	0 9	8 3	18 6
C Ditto, with potash	6 14	13 17	4 3	5 14	1 2	8 1	18 6

about using large dressings of active chemical fertilisers, especially nitrogenous ones like nitrate of soda or sulphate of ammonia, for fear that the increased yield which follows their application may lead to subsequent exhaustion or diminution of fertility; such prejudice, no doubt, being based, directly or indirectly, upon experience of the use of nitrogenous manures without due regard to the necessity of applying at the same time phosphates and (on some soils) potash, and often lime. If these mineral elements are not supplied, but have to come out of the capital fund of the soil, the free use of nitrate of soda or of sulphate of ammonia may lead temporarily to a depletion of the available natural mineral resources. But this should not be possible if due regard be had to supplying phosphates, lime and potash as well as nitrogen.

It seemed, then, a matter of interest to let a representative number of the various plots tell their own story of the after effects of the very different kinds of individual treatment to which they had been so long subjected. The result of the first season's cropping without any further application of fertilisers on 14 sections (140 plots and half-plots) is shown on pages 146 and 147.

A study of these tables will show that all the unmanured crops of 1912 have, as might be expected, done better on the "F" plots, previously treated from year to year with full dressings of stable manure, than on the "E" plots previously treated with half dressings. The heaviest yields, however, have in most cases been obtained on plots previously treated with light dressings of stable manure in conjunction with chemical fertilisers, this being especially noticeable in the case of the various crops of the cabbage kind. The difference between these plots and those which have had light dressings of stable manure only, without chemical fertilisers, is conspicuous.

It will be noticed that medium early potatoes ("Derbyshire Success") gave a good and fairly uniform crop, which was limited more by weather conditions than by differences in the soil fertility. Late potatoes ("Up to Date") did best on the plot that had previously been heavily dunged, but the influence of the previous manuring on the other plots is evident. "Early Rose" potatoes grown on another section gave only about 2 tons per acre all round in the absence of direct manuring, and less on the permanently undunged ground.

In the case of the heavily-yielding crops—namely, those of the cabbage kind and parsnips, carrots, and late potatoes—the effects of the previous heavier dressings of nitrate of soda on the "B" and "D" plots, as compared with the lighter dressings on plot "A," are in most cases evident. How far

this is due to actual residual nitrate of soda still remaining unused in the soil, or how far it may be due to improved condition of the soil brought about by higher manuring and the long continuance of greater vegetative activity thereby produced, we are unable to say. Probably it is due to both of these causes.

It will be seen that the "C" plots, previously treated with chemical fertilisers only, and having had no dung for twenty years, show on the average a residual fertility greater than that of the "E" plots (previously lightly dunged), and in some cases equal to or greater than that of the "F" plots which had previously been heavily dunged.

During the present season (1913) a second series of unmanured crops is being grown.

HOPS.

We have an acre of experimental Hops, in which we have now carried on systematic experiments during fifteen seasons; but, as the record of these is agricultural rather than horticultural, the results are published elsewhere. We shall, however, be glad to send copies of our hop records to any reader who may be interested in the matter if he will write to either of us.

CONCLUSION.

We may add that Mr. Shrivell, on our joint behalf, will be pleased, during the growing season, to see by appointment and to show over the experimental plots any of our readers who may feel disposed to pay him a visit. His postal address is "Thompson's Farm, Golden Green, Tonbridge"; and for the information of intending visitors we may mention that the village of Golden Green is near Hadlow, and about five miles by road from Tonbridge Junction station on the South Eastern Railway.

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